



MEMORANDUM

Date: August 30, 2018

To: Mike Cirian, USEPA

From: Laura Jensen, Roux

CC: John Stroiazzo, Glencore

Steve Wright, CFAC

Dick Sloan, MDEQ

Andrew Baris, Roux

Michael Ritorto, Roux

Tom Biksey, EHS Support, LLC

Subject: **Technical Memorandum to Support the Baseline Human Health Risk Assessment at the Columbia Falls Superfund Site
Former Columbia Falls Aluminum Company Aluminum Reduction Facility
Columbia Falls, Montana**

On behalf of Columbia Falls Aluminum Company, LLC (CFAC), Roux Environmental Engineering and Geology, D.P.C. (Roux) and EHS Support, LLC prepared the attached Technical Memorandum to Support the Baseline Human Health Risk Assessment (BHHRA) for the CFAC Superfund Site in Columbia Falls, Montana. This memorandum has been prepared as part of the ongoing Remedial Investigation/Feasibility Study (RI/FS) being conducted pursuant to the Administrative Settlement Agreement and Order on Consent (AOC) dated November 30, 2015, between CFAC and the United States Environmental Protection Agency (USEPA) (CERCLA Docket No. 08-2016-0002).

Should there be any questions or comments on this submission, please do not hesitate to contact me at (631) 230-2300.

Sincerely,

Laura Jensen, P.G. (NY)
Project Hydrogeologist

MEMO

To: Andrew Baris, Roux Environmental Engineering and Geology D.P.C.

From: Tom Biksey, EHS Support LLC

CC: Chrissy Peterson, EHS Support LLC
Gary Long, EHS Support LLC
Michael Ritorto, Roux Environmental Engineering and Geology D.P.C.
Laura Jensen, Roux Environmental Engineering and Geology D.P.C.

Date: August 30, 2018

Re: Technical Memorandum to Support the Baseline Human Health Risk Assessment at the
Columbia Falls Superfund Site
Former Columbia Falls Aluminum Company Aluminum Reduction Facility
Columbia Falls, Montana

Introduction

EHS Support, LLC (“EHS Support”), on behalf of Roux Environmental Engineering and Geology D.P.C. (referred to herein as Roux) and Columbia Falls Aluminum Company LLC (CFAC), is providing this Baseline Human Health Risk Assessment (BHHRA) Interim Deliverable as part of the ongoing Remedial Investigation/Feasibility Study (RI/FS) of the Superfund Site referred to as Anaconda Aluminum Co. Columbia Falls Reduction Plant (a/k/a Columbia Falls Aluminum Plant), located in Columbia Falls, Flathead County, Montana (Site; **Figure 1**). The RI/FS is being conducted pursuant to the Administrative Settlement Agreement and Order on Consent dated November 30, 2015, between CFAC and the United States Environmental Protection Agency (USEPA) (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Docket No. 08-2016-0002).

The following BHHRA Interim Deliverable was prepared to supplement the general risk assessment framework provided in the *Baseline Human Health Risk Assessment Work Plan* (BHHRA WP) submitted to USEPA and Montana Department of Environmental Quality (MDEQ) in November 2017, and revised in May 2018 (EHS Support, 2018). As specified in the BHHRA WP, this Interim Deliverable provides additional details regarding the overall approach and methodology for the following elements of the BHHRA:

- Selection of chemicals of potential concern (COPCs) in biota
- Calculation of exposure point concentrations (EPCs) for the applicable exposure scenarios, including an example calculation for one COPC per exposure area scenario for both point samples and incremental soil samples



- Risk Assessment Guidance for Superfund (RAGS) Volume I: Part D Table 4 series (i.e., the equations used to calculate uptake of COPCs, as well as the exposure assumptions used for each receptor and exposure pathway)
- RAGS Table 5 and 6 series (i.e., the non-cancer and cancer toxicity data for the COPCs evaluated in the BHHRA)

The following provides the technical approach and references the attached tables compiled for the relevant risk assessment sections that are included in this Interim Deliverable. Further evaluation of the appropriateness of exposure assumptions and model parameters presented in this Interim Deliverable may be warranted in the BHHRA to reduce uncertainty in exposure estimates used to characterize risk to receptors.

Hazard Assessment

Data Used in the Risk Assessment

The environmental data used in the BHHRA were managed in an electronic database and were compiled by constituent, medium, sample location, and sample depth, if applicable. The environmental media data collected within the human health exposure areas defined in the BHHRA Work Plan (**Figure 2**) during the Phase I Site Characterization were included in the BHHRA preliminary database. A final BHHRA database will be based on the data from all phases of site investigation. **Attachment A, Table A-1** through **Table A-12**, present the analytical fluoride data tables for each media by exposure area that is included in the Interim Deliverable.

For groundwater, three exposure areas were defined based on the following datasets:

- Plume Area Upper Hydrogeologic Unit – groundwater wells presented in Appendix 11a
- Western Undeveloped Area Upper Hydrogeologic Unit – groundwater wells presented in Appendix 11b
- Sitewide Below Upper Hydrogeologic Unit – groundwater wells presented in Appendix 11c

Selection of COPCs for Biota

The revised BHHRA Work Plan included a preliminary selection of COPCs in soils, groundwater, surface water, and sediments based upon the results of the Phase I Site Characterization. As discussed in the Work Plan, the selection of COPCs for these media will be finalized based on the evaluation of the combined results of the Phase I and Phase II Site Characterization programs. In addition, the revised BHHRA Work Plan specified that the final selection of COPCs will include the selection of COPCs for ingestion of game and fish; and, that the technical approach for the selection of COPCs in these biota will be presented in an Interim Deliverable. The technical approach for the selection of COPCs in biota is provided below.

To select COPCs for the ingestion of fish exposure pathway, regional screening levels (RSLs) will be calculated using the USEPA RSL Calculator for Ingestion of Fish (USEPA, 2018) for COPCs detected in surface water samples collected in the applicable exposure areas. Consistent with USEPA and MDEQ guidance (MDEQ, 2017) on derivation of water quality standards, an annually normalized fish ingestion



rate of 22 grams per day (g/day), or 22,000 milligrams per day (mg/day) will be used in the calculation of screening levels for fish ingestion. A target hazard quotient (THQ) of 0.1 will also be used in the calculation to account for the potential of multiple COPCs with the same toxicological endpoint.

The concentration of a COPC in fish tissue will be determined by applying a bioconcentration factor (BCF) to the maximum surface water concentration using **Equation 1**:

$$C_{\text{fish}} = C_{\text{sw}} * \text{BCF} * \text{CF} \quad \text{Equation 1}$$

Where:

- C_{fish} = concentration of COPC in fish (milligrams per kilogram [mg/kg])
- C_{sw} = concentration of COPC in surface water (micrograms per liter [μL])
- BCF = bioconcentration factor (liter per kilogram fish tissue)
- CF = conversion factor (0.001 milligrams per micrograms [mg/ μg])

The source of the BCF is the Oak Ridge National Laboratory (ORNL) Risk Assessment Information System (ORNL, 2018).

There currently are no RSLs for the selection of COPCs for the ingestion of the game tissue exposure pathway. Therefore, the residential soil RSLs will be used as a conservative method to select potential COPCs for the exposure of recreational trespasser – hunters – to game tissue affected by Site environmental media.

Exposure Assessment Exposure Point Concentrations

As specified in revised BHHRA Work Plan, the overall approach and methodology for calculation of the EPCs for the applicable exposure scenarios, including an example calculation for one COPC per exposure area scenario, will be submitted in an Interim Deliverable for USEPA review and comment before completing the BHHRA. In addition, the approach and methodology for calculation of EPCs for Incremental Soil Sampling (ISS) samples, and an example calculation of one COPC, will be included in the Interim Deliverable. This information is provided below and in **Tables 3-1 through 3-41**. In addition, this section provides the methodology to calculate EPCs for inhalation of fugitive dust by a recreationist/trespasser all-terrain vehicle (ATV) rider; and to calculate EPCs consumption of game tissue by recreationist/trespasser hunters.

As specified in the revised BHHRA WP, the EPC for each environmental media and exposure pathway will be the upper confidence limit (UCL) except as noted differently below. The EPCs will be calculated separately for discrete versus ISS samples for each applicable exposure area. For discrete samples, the 95 percent UCL of the arithmetic mean will be calculated using ProUCL Version 5.1 that was developed for the USEPA (2016) and will be dependent on the distribution of the data and will account for the uncertainty in the EPCs for Reasonable Maximum Exposure (RME) and Central Tendency Exposure (CTE), if applicable. Consistent with the Interstate Technology and Regulatory Council (ITRC) (2012), UCL_{mean} concentrations to estimate EPCs for ISS multiple decision units will be calculated using the Chebyshev UCL or Student's t UCL methods. If the 95 percent UCL of the arithmetic mean exceeds the maximum detected concentration of a COPC, the recommendation provided by the ProUCL software and guidance will be used to develop the EPC; or if a sufficient number of data points (i.e., 10 or greater) are not



available for the exposure scenario, the maximum detected concentration will be selected as the EPC. Recommendations provided by the ProUCL software for the evaluation of sample results qualified as below the detection level (non-detect) will be followed.

The EPCs for fluoride as the example COPC for each exposure media and receptor were calculated based upon the technical approach outlined above. **Attachment A, Table A-1 through Table A-12**, presents the analytical fluoride data tables for each media by exposure area that was imported into ProUCL for use in the calculations of the EPCs. The ProUCL outputs are included in **Attachment B. Table 3-1 through Table 3-41** present the calculated EPCs for one example COPC (fluoride) for each exposure media and receptor.

Equation 1 was used to calculate an EPC for fish tissue; however, the BCF was applied to the 95 percent UCL of the arithmetic mean of surface water data rather than the maximum concentration used for selection of COPCs.

The method for calculation of the EPC for fugitive dust generation and game tissue are provided below.

Fugitive Dust Generation

The calculation of an EPC for inhalation of fugitive dust while riding an ATV requires that a particulate emission factor (PEF) be estimated that describes the amount of respirable dust that is in the air. The amount of dust generated is dependent on a number of factors including speed, type and weight of the vehicle, and the type of soil. To obtain a site-specific PEF, site-specific sampling data is required to determine the actual amount of fugitive dust generated by ATVs at the Site. A surrogate for a site-specific PEF was selected based on a $PEF_{ATV} = 1.18E^{-6}$ kilograms per cubic meter (kg/m^3) developed for the Standard Mine risk assessment (SRC, 2007 and 2009) that assessed ATV recreational use. The Standard Mine risk assessment used a data set collected at the former Quincy Smelter Site in Houghton County, Michigan by the USEPA (2006). The fugitive dust data used in this evaluation were collected using a dust-sampling device while following another ATV up and down a trail over a period of approximately six hours. The total dust concentration ranged from 18.7 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) to 23,359 $\mu\text{g}/\text{m}^3$ during this time. A number of factors could contribute to the large variation in total dust concentration including distance from the lead ATV, variation in soil types, speed, and wind conditions. The mean concentration of the data was used to account for this variation. This is a conservative approach because the arithmetic mean is biased high in this case. The mean total dust concentration is 3,375 $\mu\text{g}/\text{m}^3$. Another factor with calculating the PEF is the percentage of particulate matter that is considered respirable in total dust. The respirable fraction generally refers to particulate matter with a geometric diameter of 10 micrometers (μm) or less (PM_{10}). Larger particles are typically filtered out in the nose and mouth prior to entering the airways and are not inhaled into the deeper sections of the lungs where they can enter the bloodstream. The PM_{10} fraction is largely dependent on soil type, the silt content of the soil, and the soil moisture content (USEPA, 2006). The same methodology and assumptions used in the Standard Mine risk assessment (SRC, 2007 and 2009), were used in the Health Consultation follow-up for recreational dust exposure (CDPHE, 2011). The difference in soils encountered at the Quincy Smelter Site (finer grained silt/clay soils – greater PM_{10}) from the soils at the Site (coarse grained sand/gravel soils – lower PM_{10}) will be considered in the uncertainty analysis; however, the use of this data set was deemed appropriate because it was collected during actual ATV use.



The analytical data used to develop the EPC included sampling locations located in the Western Undeveloped Area and North-Central Undeveloped Area where recreational trespasser-ATV use observations (i.e., ATV trails) were noted (CFAC personal communication) (**Figure 2**), and the Central Landfill area that did not have ATV observations, but where ATV use is assumed. The 95 percent UCL of the arithmetic mean of the soil concentrations within the three areas were used for the EPCs for fugitive dust exposure because of the limited soil data, limited sampling locations along the observed trails in the Western Undeveloped Area and North-Central Undeveloped Area, the lack of an observed trail in the Central Landfill area, and the assumption that ATVs will stray from the established ATV trails,. The calculation of an EPC for the recreational trespasser-ATV for the three exposure areas with ATV usage on the Site included the summation of the EPCs for each exposure area weighted by the area of the exposure area. **Table 3.33** provides an example calculation of the EPC with fluoride as the example COPC.

Game Tissue

The white-tailed deer was used as the example game species to estimate the EPC for a recreationist trespasser-hunter. Data specific to deer to estimate COPC concentrations in venison were not identified in the literature, but the following assumptions were used to estimate an EPC for the hunter exposure pathway:

- Deer are ruminants and, as such, are not unlike cattle; thus, it is reasonable to assume they may have similar physiological processes that could yield similar biotransfer factors. Unlike beef, however, deer meat does not undergo marbling with fat, and deer fat is quite unpalatable and likely to be trimmed rather than consumed. Therefore, the biotransfer factors for edible venison are derived by adjusting biotransfer factors for beef to account for differences in the fat content of table-ready beef. Based on data in the United States Department of Agriculture's (USDA) Food Composition Databases (USDA, 2018), a representative value for the lipid content of a strip steak was 14.6 percent, compared with 2.2 percent for ground venison (USDA, 2018).
- Transfer of COPC concentration from soil is considered; although other complete pathways may contribute to the total tissue concentration of a given contaminant in the deer (e.g., ingestion of surface water), they are likely to be negligible compared with the contributions from soil pathways.
- Bioavailability of the contaminant in soil is assumed to be 100 percent. However, estimates of site-specific bioavailability may be incorporated in the refined exposure evaluation in the BHHRA to address the potential uncertainty associated with the magnitude of exposure.

To reflect the assumptions previously noted, venison biotransfer factors were estimated by multiplying beef biotransfer factors by 2.2/14.6 (or 0.2, rounded). Thus:

$$Bv = 0.2(Bb) \quad \text{Equation 2}$$

Where:

- Bv = biotransfer factor for venison (Days per kilogram tissue wet weight [D/kg tissue WW])
- 0.2 = factor to reflect differences in fat content between beef and venison (0.2, unitless, see above)
- Bb = biotransfer factor for beef (D/kg tissue WW)



For organic compounds, biotransfer to beef factors may be estimated using the following model by Research Triangle Institute (RTI) (2005) and recommended by USEPA (2005):

$$\log Bb = -0.099 \times \log(Kow)^2 + 1.07 \times \log(Kow) - 3.56 \quad \text{Equation 3}$$

Where:

- Bb = biotransfer factor for beef (D/kg tissue WW, calculated)
- K_{ow} = octanol/water partition coefficient (unitless)

Equation 3 is appropriate for organic chemicals lacking empirical biotransfer data and having a $\log K_{ow}$ below 8.2.

Values for inorganic Bb values will be obtained from ingestion-to-beef parameters presented in Baes et al. (1984) or IAEA (1994), which are representative of the fraction of the daily elemental intake in feed that is transferred and remains in a kilogram of beef until slaughter. The Bb value for fluoride (fluorine) in this reference is 0.15 D/kg tissue WW (Baes et al., 1984).

Deer are assumed to be exposed to COPCs by ingesting browse growing on affected soil. It is estimated that deer consume approximately 1.74 kg of browse per day (Sample and Suter, 1994), which is approximately 50 percent dry matter (DM), or 0.87 kg browse DM per day (Mautz et al., 1976). The COPC concentration in browse is estimated from **Equation 4**, which was originally developed for estimating the contaminant concentration in forage to which cattle may be exposed (USEPA, 1994):

$$Cp = (Cs)(BAF_{plant}) \quad \text{Equation 4}$$

Where:

- Cp = concentration of contaminant in (plant) forage (mg/kg plant tissue dry weight [DW], calculated)
- Cs = concentration of contaminant in soil (mg/kg soil DW)
- BAF_{plant} = soil-to-plant biotransfer factor (mg/kg plant DW per mg/kg soil DW, simplified to kg soil/kg plant)

The soil-to-plant bioaccumulation factors obtained from the literature and used to estimate plant tissue COPC concentrations was used for the BAF_{plant} input variable in the venison model. BAF_{plant} values for some inorganic COPCs will be obtained from Baes et al. (1984), which presents plant uptake factors for elemental constituents in both vegetative and reproductive portions of the plant. Because deer browse year-round, and the vegetative parts are more available for the greater part of the year, BAF_{plant} values for the vegetative parts will be used. The use of the vegetative BAF_{plant} is because the translocation of nutrients and elements tends to be greater to the vegetative portion of plants. The vegetative BAF_{plant} for fluoride (fluorine) as presented in Baes et al. (1984) is 0.06.

The concentration of a COPC in venison can be estimated from **Equation 5** (adapted from USEPA [1994]), which includes contributions from both ingestion of browse and incidental soil ingestion by the deer. The soil ingestion rate for deer is assumed to be equal to two percent of its diet (Beyer et al., 1994):



$$Cv = [(FIRbrowse)(Cp)(Bv) + (SIR)(Cs)(Bv)]$$

Equation 5

Where:

- Cv = contamination concentration in venison (mg/kg WW, calculated)
- FIRbrowse = browse ingestion rate (0.87 kg DW/day)
- Cp = contamination concentration in browse DW (mg/kg)
- Bv = biotransfer factor for venison (D/kg tissue WW)
- SIR = soil ingestion rate (estimated as 2 percent of the browse ingestion rate)
- Cs = concentration in soil (mg/kg soil DW)

An area use factor (AUF) was used as an additional adjustment in the calculation of the EPC concentration in venison. As opposed to cattle, which forage in a single location or area, deer are wide-ranging species that may only be exposed to soil in the affected Site for a fraction of their daily activities. The AUF is simply a ratio of the size of the Site to the size of a deer's home range. The home range of a deer is assumed to be the upper bound of the foraging range presented in Sample and Suter (1994). The example includes a hypothetical deer foraging randomly with the terrestrial exposure areas of the CFAC facility (excluding Flathead River and the Backwater Seep Sampling Area). The AUF-adjusted COPC tissue concentrations are used to calculate the Site-wide venison concentration based on the (spatially weighted) deer tissue concentrations at each individual exposure area. The spatial weighting was based on Geographic Information System (GIS) aerial mapping of the Site exposure areas versus Site vegetative habitat and was adjusted to take into account portions of the facility that do not support foraging habitat for the deer. For example, the spatial footprint of a paved parking lot would be excluded from the AUF calculations, and any soil samples from that area may be excluded from the soil exposure point concentration for the venison model, due to the lack of vegetation for browsing. **Table C-1 (Attachment C)** presents the venison COPC uptake model and AUF EPC for assessing the hunter exposure scenario. Seasonal use may also be considered in the calculation of the AUF to estimate the exposure duration for receptors that may only be present seasonally at the Site. Seasonal use will initially be assumed to be 100 percent; however, estimates of seasonal use may be incorporated into the AUF for the refined exposure evaluation in the BHRA to address the potential uncertainty associated with the duration of exposure for seasonal receptors at the Site.

Exposure Equations and Assumptions

The equations that will be used to calculate uptake of COPCs, as well as the exposure assumptions for each receptor and exposure pathway, are presented in **Table 4-1** through **Table 4-6**. Site-specific exposure assumptions for the workers (i.e., industrial, stormwater, and construction), recreationists (i.e., boater, floater, hunter, ATV rider, and fisher), and trespasser will be used in place of default exposure assumptions. These site-specific assumptions are based on factors such as type of recreation anticipated (e.g., hunting, fishing, boating, floating), Site features (e.g., accessibility, vegetation), security measures (e.g., posted) in place, and proximity to residential properties. In addition, the MDEQ has determined that there was no location in Montana for which climate data were available that did not have a minimum of 4 months of an average snow depth with at least 2 inches, or an average temperature at or below freezing, or both (MDEQ, 2016). However, MDEQ calculated the exposure frequencies using 75 percent of the typical exposure frequency (e.g., for residents, 75 percent of 365 days equaled 270 days of exposure to soils). Therefore, this same conservative exposure frequency assumption (i.e., 75 percent) for surface soil and dust exposure (ingestion, dermal, and inhalation) was



used. Other exposure assumptions (e.g., body weight, skin surface area) are based upon the type of receptor and use and were provided in the default guidance documents referenced in the BHHRA Work Plan and listed in the reference section herein. The Montana Fish, Wildlife, and Parks website (e.g., Hunter access guide <https://myfwp.mt.gov/fwpPub/hunterAccessGuide>) was searched for site-specific information on hunting and fishing seasons, recreational fish and game species, breeding and foraging habitat requirements, creel and bag limits, harvest reports, and distribution and population statistics. Interviews were also conducted with the following individuals:

- Steve Wright, Health and Safety Coordinator, Columbia Falls Aluminum Company LLC – Mr. Wright provided observational information on the activities of recreational trespassers that engage in hunting and ATV riding.
- Rich Birdsell, Owner of Northern Rockies Outfitters, Kalispell, Montana – Mr. Birdsell provided local knowledge regarding recreational and fishing use of the Flathead River near the CFAC Site.
- Kristy Personett, Montana Fish, Wildlife, and Parks, Region 1 – Ms. Personett manages CFAC's Block Management Program (BMP) that provides managed hunting on their land south of the Flathead River; she provided local information on hunting in this area.

The following presents a discussion on Site-specific exposure assumptions that will be used in the BHHRA:

- A stormwater management worker is anticipated to conduct an inspection of the North Percolation Pond and Central Landfill areas once per week for approximately 1 hour per inspection (Steve Wright, personal communication). Consistent with the MDEQ exposure frequency surface soil recommendations, the stormwater management worker is assumed to be exposed to soils 8 months of the year or 38 weeks; therefore, the exposure frequency is 38 days per year for this receptor. The same exposure frequency is assumed for surface water and sediment.
- The reasonable maximum exposure for the recreationist (i.e., boater and floater) receptor is an exposure frequency of 10 days per year for 1 hour per lunch visit to the Backwater Seep Sampling Area (Rich Birdsell, personal communication). An adolescent recreationist is considered to be 6 to 16 years old; therefore, the exposure duration for the adolescent recreationist is 10 years. An exposure duration of 20 years is assumed for the adult recreationist. For the purposes of dermal exposure, the surface area is assumed to be whole body and is based on USEPA defaults for the adolescent and adult floaters and the exposure time is assumed to be 1 hour per visit.
- The fisher has an estimated exposure frequency of 10 days per year for 20 years and an exposure time of 1 hour per lunch visit to the Backwater Seep Sampling Area (Rich Birdsell, personal communication). Additionally, a fisher is conservatively assumed to keep 2 fish per day of fishing to consume that corresponds to 2 fish meals. A typical meal is assumed to be 8 ounces per day, or 227 grams per day of fish. Therefore, the fish ingestion rate, normalized for one year, of 12,971 milligrams per day is assumed for this receptor.
- Because of the migratory nature of the fish caught by the fisher, and the lack of spawning areas along the reach of the Flathead River adjacent to the Site, the fish are not expected to be exposed to the surface waters within the Backwater Seep Sampling Area except for incidental incursions (Rich Birdsell, personal communication). Therefore, a migration ratio (MR) of 10 percent was applied to the relative percentage of time the fish would be exposed to COPCs within the Backwater Seep Sampling Area. This is a conservative migration ratio given the small



surface water habitat within the Backwater Seep Sampling Area and the migratory nature of the fish species.

- The trespasser is an adolescent from 6 to 16 years of age and is assumed to access the Site 7 days per year (Steve Wright, personal communication).
- The recreationist trespasser – hunter is assumed to access the Site 14 days per hunting season (Rich Birdsell, personal communication); for deer, the hunting season is September through November, and one deer is bagged for home consumption. The average weight of dressed deer is approximately 63 kg (average buck and doe, MDEQ website), and approximately 50 percent is edible venison. Therefore, the venison ingestion rate, normalized for one year, is 0.086 kg/day.
- The recreationist trespasser – ATV rider is assumed to access the Site one day per month (Steve Wright, personal communication).

Chemical-specific properties will be presented in **Table 4-7**; the data for fluoride is included as an example.

Toxicological Assessment

Table 5-1 and **Table 5-2** present the reference doses (RfDs) and reference concentrations (RfCs) selected for all the COPCs that were initially selected in the BHRRA Work Plan, and their target organs. **Table 6-1** and **Table 6-2** present the cancer slope factors (CSFs) and unit risk factors (URFs) for all the COPCs that were initially selected in the BHRRA Work Plan. These tables also include the toxicological data references. The tables will be updated to reflect additional COPCs, if any, based upon the re-screening of the entire RI data set following the completion of Phase II Site Characterization.

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Tables

Preliminary - Under EPA and MDEQ Review

Table 3-1
Exposure Point Concentration Summary (Main Plant Area - Soil 0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Main Plant Area Soil
Exposure Medium: Surface Soil (0 to 0.5 ft-bgs)

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Suface Soil 0-0.5 ft-bgs	16984-48-8	Fluoride	mg/kg	76.55	129.1 NP	571	129.1	mg/kg	95% UCL	95% Chebyshev(Mean, Sd) UCL

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ NP = non-parametric

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-2
Exposure Point Concentration Summary (Main Plant Area - Soil 0-12 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Future
Medium: Main Plant Area Soil
Exposure Medium: Subsurface Soil (0 to 12 ft-bgs)

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Subsurface Soil 0-12 ft-bgs	16984-48-8	Fluoride	mg/kg	52.97	73.91 L	571	73.91	mg/kg	UCL	95% H-UCL (KM-Log)

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-3
Exposure Point Concentration Summary (North Percolation Pond Area - Soil 0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: North Percolation Pond Area Soil
Exposure Medium: Surface Soil (0 to 0.5 ft-bgs)

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Soil 0-0.5 ft-bgs	16984-48-8	Fluoride	mg/kg	NA	NA	241	241	mg/kg	Maximum	Not enough data to perform statistics

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-4
Exposure Point Concentration Summary (North Percolation Pond Area - Soil 0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: North Percolation Pond Area Soil
Exposure Medium: Surface Soil (0 to 2 ft-bgs)

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Soil 0-2 ft-bgs	16984-48-8	Fluoride	mg/kg	106.7	138.1 N	258	138.1	mg/kg	95% UCL	95% Student's-t UCL

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ N = normal

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-5
Exposure Point Concentration Summary (North Percolation Pond Area - Soil 0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Future
Medium: North Percolation Pond Area Soil
Exposure Medium: Subsurface Soil (0 to 12 ft-bgs)

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Subsurface Soil 0-12 ft-bgs	16984-48-8	Fluoride	mg/kg	78.85	116.2 G	258	116.2	mg/kg	95% UCL	95% Adjusted Gamma UCL (n<50)

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ G = gamma

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-6
Exposure Point Concentration Summary (North Percolation Pond Area - Surface Water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: North Percolation Pond Area Surface Water
Exposure Medium: Surface Water

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Water	16984-48-8	Fluoride	µg/l	NA	NA	22400	22400	µg/l	Maximum	Not enough data to perform statistics

Footnotes:

a/ µg/l = milligrams per liter

b/ NA = not applicable

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-7
Exposure Point Concentration Summary (North Percolation Pond Area - Sediment)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: North Percolation Pond Area Sediment
Exposure Medium: Sediment

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Sediment	16984-48-8	Fluoride	mg/kg	NA	NA	219	219	mg/kg	Maximum	Not enough data to perform statistics

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-8
Exposure Point Concentration Summary (Central Landfill Area - Soil 0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Central Landfill Area Soil
Exposure Medium: Surface Soil (0 to 0.5 ft-bgs)

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Soil 0-0.5 ft-bgs	16984-48-8	Fluoride	mg/kg	63.1	84.92 G	210	84.92	mg/kg	95% UCL	95% Adjusted Gamma UCL (n<50)

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ G = gamma

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-9
Exposure Point Concentration Summary (Central Landfill Area - Soil 0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Central Landfill Area Soil
Exposure Medium: Surface Soil (0 to 2 ft-bgs)

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Soil 0-2 ft-bgs	16984-48-8	Fluoride	mg/kg	58.44	70.94 G	210	70.94	mg/kg	95% UCL	95% Adjusted Gamma UCL (n>50)

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ G = gamma

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-10
Exposure Point Concentration Summary (Central Landfill Area - Soil 0-12 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Future
Medium: Central Landfill Area Soil
Exposure Medium: Subsurface Soil (0 to 12 ft-bgs)

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Subsurface Soil 0-12 ft-bgs	16984-48-8	Fluoride	mg/kg	43.9	53.5 G	210	53.5	mg/kg	95% UCL	95% Adjusted Gamma UCL (n>50)

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ G = gamma

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-11
Exposure Point Concentration Summary (Central Landfill Area - Surface Water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Central Landfill Area Surface Water
Exposure Medium: Surface Water

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Water	16984-48-8	Fluoride	µg/l	NA	NA	2600	2600	µg/l	Maximum	Not enough data to perform statistics

Footnotes:

a/ µg/l = milligrams per liter

b/ NA = not applicable

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-12
Exposure Point Concentration Summary (Industrial Landfill Area - Soil 0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Industrial Landfill Area Soil
Exposure Medium: Surface Soil (0 to 0.5 ft-bgs)

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Soil 0-0.5 ft-bgs	16984-48-8	Fluoride	mg/kg	NA	NA	4.17	4.17	mg/kg	Maximum	Not enough data to perform statistics

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-13
Exposure Point Concentration Summary (Industrial Landfill Area - Soil 0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Industrial Landfill Area Soil
Exposure Medium: Surface Soil (0 to 2 ft-bgs)

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Soil 0-2 ft-bgs	16984-48-8	Fluoride	mg/kg	NA	NA	37.8	37.8	mg/kg	Maximum	Not enough data to perform statistics

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-14
Exposure Point Concentration Summary (Industrial Landfill Area - Soil 0-12 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Future
Medium: Industrial Landfill Area Soil
Exposure Medium: Subsurface Soil (0 to 12 ft-bgs)

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Subsurface Soil 0-12 ft-bgs	16984-48-8	Fluoride	mg/kg	NA	NA	37.8	37.8	mg/kg	Maximum	Not enough data to perform statistics

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-15
Exposure Point Concentration Summary (Eastern Undeveloped Area - Surface Water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Eastern Undeveloped Area Surface Water
Exposure Medium: Surface Water

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Water	16984-48-8	Fluoride	µg/l	NA	NA	188	188	µg/l	Maximum	Not enough data to perform statistics

Footnotes:

a/ µg/l = milligrams per liter

b/ NA = not applicable

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-16
Exposure Point Concentration Summary (North Central Undeveloped Area - Soil 0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: North Central Undeveloped Area Soil
Exposure Medium: Surface Soil (0 to 0.5 ft-bgs)

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Soil 0-0.5 ft-bgs	16984-48-8	Fluoride	mg/kg	NA	NA	27.6	27.6	mg/kg	Maximum	Not enough data to perform statistics

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-17
Exposure Point Concentration Summary (North Central Undeveloped Area - Soil 0-12 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Future
Medium: North Central Undeveloped Area Soil
Exposure Medium: Subsurface Soil (0 to 12 ft-bgs)

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Subsurface Soil 0-12 ft-bgs	16984-48-8	Fluoride	mg/kg	9.799	13.9 N	27.6	13.9	mg/kg	Maximum	Not enough data to perform statistics

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ N = normal

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-18
Exposure Point Concentration Summary (North Central Undeveloped Area - Surface Water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: North Central Undeveloped Area Surface Water
Exposure Medium: Surface Water

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Water	16984-48-8	Fluoride	µg/l	218	284.6 N	473	284.6	µg/l	95% UCL	95% Student's-t UCL

Footnotes:

a/ µg/l = milligrams per liter

b/ NA = not applicable

c/ N = non-parametric

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-19
Exposure Point Concentration Summary (Western Undeveloped Area - Soil 0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Western Undeveloped Area Soil
Exposure Medium: Surface Soil 0 to 0.5

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Soil 0-0.5 ft-bgs	16984-48-8	Fluoride	mg/kg	8.178	10.68 N	15.4	10.68	mg/kg	UCL	95% Student's-t UCL

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ Note, total chromium will be evaluated as chromium III and chromium VI on a 6:1 ratio.

d/ N = normal

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-20
Exposure Point Concentration Summary (Western Undeveloped Area - Surface Water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Western Undeveloped Area Surface Water
Exposure Medium: Surface Water

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Water	16984-48-8	Fluoride	µg/l	114.8	126.9 NP	137	126.9	µg/l	95% UCL	95% Modified-t UCL (Johnson-1978)

Footnotes:

a/ µg/l = milligrams per liter

b/ NA = not applicable

c/ NP = non-parametric

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-21
Exposure Point Concentration Summary (South Percolation Pond - Soil 0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: South Percolation Ponds Area Soil
Exposure Medium: Surface Soil 0 to 0.5

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Suface Soil 0-0.5 ft-bgs	16984-48-8	Fluoride	mg/kg	14.19	17.95 N	44.1	17.95	mg/kg	UCL	95% Student's-t UCL

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ N = normal

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-22
Exposure Point Concentration Summary (South Percolation Pond - Soil 0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: South Percolation Ponds Area Soil
Exposure Medium: Surface Soil 0 to 2

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Suface Soil 0-2 ft-bgs	16984-48-8	Fluoride	mg/kg	0.558	0.635 L	16.4	0.635	mg/kg	UCL	95% H-UCL (KM-Log)

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ L = lognormal

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-23
Exposure Point Concentration Summary (South Percolation Pond - Surface Water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: South Percolation Ponds Area Surface Water
Exposure Medium: Surface Water

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Water	16984-48-8	Fluoride	µg/l	1447	3823 NP	9240	3823	µg/l	UCL	95% Chebyshev (Mean, Sd) UCL

Footnotes:

a/ µg/l = micrograms per liter

b/ NA = not applicable

c/ NP = non-parametric

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-24
Exposure Point Concentration Summary (South Percolation Pond - Sediment)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: South Percolation Ponds Area Sediment
Exposure Medium: Sediment

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Sediment	16984-48-8	Fluoride	mg/kg	48.56	96.72 G	195	96.72	mg/kg	UCL	95% Adjusted Gamma UCL (n<50) UCL

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ G = gamma

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-25
Exposure Point Concentration Summary (Flat Head River - Surface Water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Flathead River Area Surface Water
Exposure Medium: Surface Water

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Water	16984-48-8	Fluoride	µg/l	220.2	636 NP	2160	636	µg/l	UCL	95% Chebyshev (Mean, Sd) UCL

Footnotes:

a/ µg/l = micrograms per liter

b/ NA = not applicable

c/ NP = non-parametric

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-26
Exposure Point Concentration Summary (Backwater Seep Area - Soil 0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Backwater Seep Area Soil
Exposure Medium: Surface Soil 0 to 0.5

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Soil 0-0.5 ft-bgs	16984-48-8	Fluoride	mg/kg	NA	NA	32.7	32.7	mg/kg	Maximum	Not enough data for statistics

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-27
Exposure Point Concentration Summary (Backwater Seep Area - Soil 0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Backwater Seep Area Soil
Exposure Medium: Surface Soil 0 to 2

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Soil 0-2 ft-bgs	16984-48-8	Fluoride	mg/kg	19.14	23.04 N	33.5	23.04	mg/kg	UCL	95% Student's-t UCL

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ N = normal

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-28
Exposure Point Concentration Summary (Backwater Seep Sampling Area- Surface Water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Backwater Seep Area Surface Water
Exposure Medium: Surface Water

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Surface Water	16984-48-8	Fluoride	µg/l	1141	1841 G	2,640	1841	µg/l	95% UCL	95% Gamma Adjusted UCL (n<50)

Footnotes:

a/ micrograms per liter

b/ NA = not applicable

c/ G = gamma

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-29
Exposure Point Concentration Summary (Backwater Seep Sampling Area- Sediment)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Backwater Seep Area Sediment
Exposure Medium: Sediment

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Sediment	16984-48-8	Fluoride	mg/kg	NA	NA	24.8	24.8	mg/kg	Maximum	Not enough data for statistics

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

CAS = Chemical CAS = Chemical Abstracts Service

UCL = upper con UCL = upper confidence limit

Table 3-30
Exposure Point Concentration Summary (Groundwater - Plume Area Upper Hydrogeologic Unit)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium:Groundwater - Plume Area Upper Hydrogeologic Unit
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Tapwater	16984-48-8	Fluoride	µg/l	4699	7708 NP	52900	7708	µg/l	UCL	95% KM Chebyshev UCL

Footnotes:

a/ µg/l = micrograms per liter

b/ NA = not applicable

c/ NP = non-parametric

CAS = Chemical CAS = Chemical Abstracts Service

UCL = upper con UCL = upper confidence limit

Table 3-31
Exposure Point Concentration Summary (Groundwater - Western Undeveloped Area Upper Hydrogeologic Unit)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Groundwater - Western Undeveloped Area Upper Hydrogeologic Unit
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Tapwater	16984-48-8	Fluoride	µg/l	NA	NA	271	271	µg/l	Maximum	Not enough data for statistics

Footnotes:

a/ µg/l = micrograms per liter

b/ NA = not applicable

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-32
Exposure Point Concentration Summary (Groundwater -Sitewide Below Upper Hydrogeologic Unit)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium:Groundwater - Sitewide Below Upper Hydrogeologic Unit
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic	Rationale
Tapwater	16984-48-8	Fluoride	µg/l	241.2	278.2 G	569	278.2	µg/l	UCL	95% Gamma Approximate UCL (n>= 50)

Footnotes:

a/ µg/l = micrograms per liter

b/ NA = not applicable

c/ G = gamma

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-33
Exposure Point Concentration Summary (ATV Exposure Areas - Soil 0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: ATV Exposure Areas Soil
Exposure Medium: Surface Soil 0 to 0.5

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration						
							Central Landfills	North Central	Western Undeveloped	EPC	Units	Statistic	Rationale
Surface Soil 0-0.5 ft-bgs	16984-48-8	Fluoride	mg/kg	NA	NA	NA	84.92	27.6	10.68	29.5	mg/kg	See Footnote	Refer to text.

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ EPC for ATV areas is the surface soil (0 - 0.5 ft-bgs) EPC from the following areas weighted by the amount shown. Refer to text for additional discussion.

Area	Area (acres)	Area Weight (%)	EPC Table
Central Landfills Area	127.8	19.1%	Table 3.8
North Central Area	182.9	27.4%	Table 3.16
Western Undeveloped Area	357.3	53.5%	Table 3.19

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-34
Exposure Point Concentration Summary (Hunter Exposure Areas - Soil 0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Hunter Exposure Areas Soil
Exposure Medium: Surface Soil 0 to 0.5

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration					
							North Central	Western Undeveloped	EPC	Units	Statistic	Rationale
Surface Soil 0-0.5 ft-bgs	16984-48-8	Fluoride	mg/kg	NA	NA	NA	27.6	10.68	16.4	mg/kg	See Footnote	Refer to text.

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ EPC for ATV areas is the surface soil (0 - 0.5 ft-bgs) EPC from the following areas weighted by the amount shown. Refer to text for additional discussion.

Area	Area (acres)	Area Weight (%)	EPC Table
North Central Area	182.9	33.9%	Table 3.16
Western Undeveloped Area	357.3	66.1%	Table 3.19

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-35
Exposure Point Concentration Summary (Backwater Seep Sampling Area- Fish)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Backwater Seep Area Surface Water
Exposure Medium: Fish

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration							
							Surface Water			Fish Tissue			Statistic	Rationale
							Value	Units	BCF	Value	Units			
Fish	16984-48-8	Fluoride	µg/l	1,141	1841 G	2,640	1841	µg/l	10	18.41	mg/kg	95% UCL	95% Gamma Adjusted UCL (n<50)	

Footnotes:

a/ µg/l = micrograms per liter

b/ NA = not applicable

c/ G = gamma

d/ Refer to text for bicentration factor (BCF) reference(s) and equations for calculation of fish tissue EPC.

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-36
Exposure Point Concentration Summary (Flathead River Area- Fish)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Flathead River Area Surface Water
Exposure Medium: Fish

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration							
							Surface Water			Fish Tissue			Statistic	Rationale
							Value	Units	BCF	Value	Units			
Fish	16984-48-8	Fluoride	µg/l	220	636 NP	2,160	636	µg/l	10	6.36	mg/kg	UCL	95% Chebyshev (Mean, Sd) UCL	

Footnotes:

a/ µg/l = micrograms per liter

b/ NA = not applicable

c/ NP = non-parametric

d/ Refer to text for bicentration factor (BCF) reference(s) and equations for calculation of fish tissue EPC.

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-37
Exposure Point Concentration Summary (Whitetail Deer)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: Vegetated Areas Surface Soil (0-0.5 ft-bgs)
Exposure Medium: Whitetail deer

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Venison		Statistic	Rationale
							Value	Units		
Venison	16984-48-8	Fluoride	mg/kg	NA	NA	NA	0.053	mg/kg	See Footnote	Refer to text.

Footnotes:

a/ µg/l = micrograms per liter

b/ NA = not applicable

c/ Refer to text for discussion on calculation of EPC for the venison uptake by a hunter.

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-38
Exposure Point Concentration Summary (ISS Samples - Main Plant Area - Surface Soil 0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: ISS Samples - Main Plant Area - Surface Soil
Exposure Medium: Surface Soil 0-0.5 ft-bgs

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Fish Tissue		Statistic	Rationale
							Value	Units		
Surface Soil 0-0.5 ft-bgs	16984-48-8	Fluoride	mg/kg	286	498.7 NP	632	498.7	mg/kg	UCL	95% Chebyshev (Mean, Sd) UCL

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ NP = non-parametric

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-39
Exposure Point Concentration Summary (ISS Samples - Main Plant Area - Surface Soil 0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: ISS Samples - Main Plant Area - Surface Soil
Exposure Medium: Surface Soil 0-2 ft-bgs

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Fish Tissue		Statistic	Rationale
							Value	Units		
Surface Soil 0-2 ft-bgs	16984-48-8	Fluoride	mg/kg	298.3	464.9 NP	946	464.9	mg/kg	UCL	95% Chebyshev (Mean, Sd) UCL

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ NP = non-parametric

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-40
Exposure Point Concentration Summary (ISS Samples - Central Landfill Area - Surface Soil 0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: ISS Samples - Central Landfill Area - Surface Soil
Exposure Medium: Surface Soil 0-0.5 ft-bgs

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Fish Tissue		Statistic	Rationale
							Value	Units		
Surface Soil 0-0.5 ft-bgs	16984-48-8	Fluoride	mg/kg	232	432 NP	976	432	mg/kg	UCL	95% Chebyshev (Mean, Sd) UCL

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ NP = non-parametric

CAS = Chemical Abstracts Service

UCL = upper confidence limit

Table 3-41
Exposure Point Concentration Summary (ISS Samples - Central Landfill Area - Surface Soil 0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current
Medium: ISS Samples - Central Landfill Area - Surface Soil
Exposure Medium: Surface Soil 0-2 ft-bgs

Exposure Point	CAS Number	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Fish Tissue		Statistic	Rationale
							Value	Units		
Surface Soil 0-2 ft-bgs	16984-48-8	Fluoride	mg/kg	230	370.2 NP	976	370.2	mg/kg	UCL	95% Chebyshev (Mean, Sd) UCL

Footnotes:

a/ mg/kg = milligrams per kilogram

b/ NA = not applicable

c/ NP = non-parametric

CAS = Chemical Abstracts Service

UCL = upper confidence limit

TABLE 4-1
Exposure Equations and Assumptions - Current/Future Scenario: Soil and Sediment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil/Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name
Ingestion	Industrial Worker	Adult	Soil	CS IR _{soil} RBA EF ED BW AT-NC AT-C CF _{soil}	Chemical Concentration in Soil Soil ingestion Relative bioavailability factor Exposure frequency Exposure duration Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 100 chemical-specific 187 25 80 9,125 25,550 1.0E-06	mg/kg mg/d unitless day/yr yr kg days days kg/mg	See Table 3s USEPA, 2018 USEPA, 2018 MDEQ, 2016 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 1989	Chronic Daily Intake (CDI) (mg/kg-day) = $\frac{CS \times IR_{soil} \times RBA \times EF \times ED \times CF}{BW \times AT}$
	Construction Worker	Adult	Soil	CS IR _{soil} RBA EF ED BW AT-NC AT-C CF _{soil}	Chemical Concentration in Soil Soil ingestion Relative bioavailability factor Exposure frequency Exposure duration Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 330 chemical-specific 124 1 80 365 25,550 1.0E-06	mg/kg mg/d unitless day/yr yr kg days days kg/mg	See Table 3s USEPA, 2018 USEPA, 2018 MDEQ, 2016 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 1989	Chronic Daily Intake (CDI) (mg/kg-day) = $\frac{CS \times IR_{soil} \times RBA \times EF \times ED \times CF}{BW \times AT}$
	Stormwater Management Worker	Adult	Soil/ Sediment	CS IR _{soil} RBA EF ED BW AT-NC AT-C CF _{soil}	Chemical Concentration in Soil Soil ingestion Relative bioavailability factor Exposure frequency Exposure duration Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 100 chemical-specific 38 25 80 9,125 25,550 1.0E-06	mg/kg mg/d unitless day/yr yr kg days days kg/mg	See Table 3s USEPA, 2018 USEPA, 2018 BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 1989	Chronic Daily Intake (CDI) (mg/kg-day) = $\frac{CS \times IR_{soil} \times RBA \times EF \times ED \times CF}{BW \times AT}$
	Recreational Trespasser (ATV)	Adult	Soil/ Sediment	CS IR _{soil} RBA EF ED BW AT-NC AT-C CF _{soil}	Chemical Concentration in Soil Soil ingestion Relative bioavailability factor Exposure frequency Exposure duration Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 100 chemical-specific 9 20 80 7,300 25,550 1.0E-06	mg/kg mg/d unitless day/yr yr kg days days kg/mg	See Table 3s USEPA, 2018 USEPA, 2018 BPJ BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 1989	Chronic Daily Intake (CDI) (mg/kg-day) = $\frac{CS \times IR_{soil} \times RBA \times EF \times ED \times CF}{BW \times AT}$
	Recreational Trespasser (Hunter)	Adult	Soil/ Sediment	CS IR _{soil} RBA EF ED BW AT-NC AT-C CF _{soil}	Chemical Concentration in Soil Soil ingestion Relative bioavailability factor Exposure frequency Exposure duration Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 100 chemical-specific 14 20 80 7,300 25,550 1.0E-06	mg/kg mg/d unitless day/yr yr kg days days kg/mg	See Table 3s USEPA, 2018 USEPA, 2018 BPJ BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 1989	Chronic Daily Intake (CDI) (mg/kg-day) = $\frac{CS \times IR_{soil} \times RBA \times EF \times ED \times CF}{BW \times AT}$

TABLE 4-1
Exposure Equations and Assumptions - Current/Future Scenario: Soil and Sediment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil/Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name
Ingestion	Resident	Adult	Soil	CS IR _{soil} RBA EF ED BW AT-NC AT-C CF _{soil}	Chemical Concentration in Soil Soil ingestion Relative bioavailability factor Exposure frequency Exposure duration Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 100 chemical-specific 270 20 80 7,300 25,550 1.0E-06	mg/kg mg/d unitless day/yr yr kg days days kg/mg	See Table 3s USEPA, 2018 USEPA, 2018 MDEQ, 2016 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 1989	Chronic Daily Intake (CDI) (mg/kg-day) = $\frac{CS \times IR_{soil} \times RBA \times EF \times ED \times CF}{BW \times AT}$
	Resident	Child	Soil	CS IR _{soil} RBA EF ED BW AT-NC AT-C CF _{soil}	Chemical Concentration in Soil Soil ingestion Relative bioavailability factor Exposure frequency Exposure duration Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 200 chemical-specific 270 6 15 2,190 25,550 1.0E-06	mg/kg mg/d unitless day/yr yr kg days days kg/mg	See Table 3s USEPA, 2018 USEPA, 2018 MDEQ, 2016 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA 1989	Chronic Daily Intake (CDI) (mg/kg-day) = $\frac{CS \times IR_{soil} \times RBA \times EF \times ED \times CF}{BW \times AT}$
	Recreationist (Floater)	Adolescent (6-16 years)	Soil/ Sediment	CS IR _{soil} RBA EF ED BW AT-NC AT-C CF _{soil}	Chemical Concentration in Soil Soil ingestion Relative bioavailability factor Exposure frequency Exposure duration Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 100 chemical-specific 10 10 80 3,650 25,550 1.0E-06	mg/kg mg/d unitless day/yr yr kg days days kg/mg	See Table 3s USEPA, 2018 USEPA, 2018 BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA 1989	Chronic Daily Intake (CDI) (mg/kg-day) = $\frac{CS \times IR_{soil} \times RBA \times EF \times ED \times CF}{BW \times AT}$
	Recreationist (Floater)	Adult	Soil/ Sediment	CS IR _{soil} RBA EF ED BW AT-NC AT-C CF _{soil}	Chemical Concentration in Soil Soil ingestion Relative bioavailability factor Exposure frequency Exposure duration Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 100 chemical-specific 10 20 80 7,300 25,550 1.0E-06	mg/kg mg/d unitless day/yr yr kg days days kg/mg	See Table 3s USEPA, 2018 USEPA, 2018 BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA 1989	Chronic Daily Intake (CDI) (mg/kg-day) = $\frac{CS \times IR_{soil} \times RBA \times EF \times ED \times CF}{BW \times AT}$
	Recreationist (Fisher)	Adult	Soil/ Sediment	CS IR _{soil} RBA EF ED BW AT-NC AT-C CF _{soil}	Chemical Concentration in Soil Soil ingestion Relative bioavailability factor Exposure frequency Exposure duration Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 100 chemical-specific 10 20 80 7,300 25,550 1.0E-06	mg/kg mg/d unitless day/yr yr kg days days kg/mg	See Table 3s USEPA, 2018 USEPA, 2018 BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA 1989	Chronic Daily Intake (CDI) (mg/kg-day) = $\frac{CS \times IR_{soil} \times RBA \times EF \times ED \times CF}{BW \times AT}$

TABLE 4-1
Exposure Equations and Assumptions - Current/Future Scenario: Soil and Sediment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil/Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name
Ingestion	Trespasser	Adolescent (6-16 years)	Soil/Sediment	CS IR _{soil} RBA EF ED BW AT-NC AT-C CF _{soil}	Chemical Concentration in Soil Soil ingestion Relative bioavailability factor Exposure frequency Exposure duration Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 100 chemical-specific 50 10 80 3,650 25,550 1.0E-06	mg/kg mg/d unitless day/yr yr kg days days kg/mg	See Table 3s USEPA, 2018 USEPA, 2018 MDEQ, 2017 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA 1989	Chronic Daily Intake (CDI) (mg/kg-day) = $\frac{CS \times IR_{soil} \times RBA \times EF \times ED \times CF}{BW \times AT}$
Dermal	Industrial Worker	Adult	Soil	CS SA ABS-d AF EF ED EV BW AT-NC AT-C CF _{soil}	Chemical Concentration in Soil Surface area for contact Dermal absorption factor-VOCs Adherence factor, adult Exposure frequency Exposure duration Event Frequency Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 3,527 chemical-specific 0.12 187 25 1 80 9,125 25,550 1.0E-06	mg/kg cm ² /day unitless mg/cm ² day/yr yr events/day kg days days kg/mg	See Table 3s USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2011 USEPA, 2011 EPA, 2001 USEPA, 2011 USEPA, 2011 USEPA, 2011 USEPA 1989	Dermal Absorbed Dose (DAD) (mg/kg-day) = $(DA-event \times EF \times ED \times EV \times SA) / (AT \times BW)$ where Absorbed Dose per Event (DA-event) (mg/cm ² -event) = $CS \times CF \times AF \times ABS-d$
	Construction Worker	Adult	Soil	CS SA ABS-d AF EF ED EV BW AT-NC AT-C CF _{soil}	Chemical Concentration in Soil Surface area for contact Dermal absorption factor-VOCs Adherence factor, adult Exposure frequency Exposure duration Event Frequency Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 3,527 chemical-specific 0.3 124 1 1 80 365 25,550 1.0E-06	mg/kg cm ² /day unitless mg/cm ² day/yr yr events/day kg days days kg/mg	See Table 3s USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2011 USEPA, 2011 EPA, 2001 USEPA, 2011 USEPA, 2011 USEPA, 2011 USEPA 1989	Dermal Absorbed Dose (DAD) (mg/kg-day) = $(DA-event \times EF \times ED \times EV \times SA) / (AT \times BW)$ where Absorbed Dose per Event (DA-event) (mg/cm ² -event) = $CS \times CF \times AF \times ABS-d$
	Stormwater Management Worker	Adult	Soil/Sediment	CS SA ABS-d AF EF ED EV BW AT-NC AT-C CF _{soil}	Chemical Concentration in Soil Surface area for contact Dermal absorption factor-VOCs Adherence factor, adult Exposure frequency Exposure duration Event Frequency Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 3,527 chemical-specific 0.12 38 25 1 80 9,125 25,550 1.0E-06	mg/kg cm ² /day unitless mg/cm ² day/yr yr events/day kg days days kg/mg	See Table 3s USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2011 USEPA, 2011 EPA, 2001 USEPA, 2011 USEPA, 2011 USEPA, 2011 USEPA 1989	Dermal Absorbed Dose (DAD) (mg/kg-day) = $(DA-event \times EF \times ED \times EV \times SA) / (AT \times BW)$ where Absorbed Dose per Event (DA-event) (mg/cm ² -event) = $CS \times CF \times AF \times ABS-d$

TABLE 4-1
Exposure Equations and Assumptions - Current/Future Scenario: Soil and Sediment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil/Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name
Dermal	Recreational Trespasser (ATV)	Adult	Soil/ Sediment	CS SA ABS-d AF EF ED EV BW AT-NC AT-C CFsoil	Chemical Concentration in Soil Surface area for contact Dermal absorption factor-VOCs Adherence factor Exposure frequency Exposure duration Event Frequency Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 3,527 chemical-specific 0.12 9 20 1 80 7,300 25,550 1.0E-06	mg/kg cm ² /day unitless mg/cm ² day/yr yr events/day kg days days kg/mg	See Table 3s BPJ USEPA 2004 USEPA, 2018 BPJ BPJ EPA, 2001 USEPA, 2011 USEPA, 2011 USEPA, 2011 USEPA 1989	Dermal Absorbed Dose (DAD) (mg/kg-day) = (DA-event x EF x ED x EV x SA) / (AT x BW) where Absorbed Dose per Event (DA-event) (mg/cm ² -event) = CS x CF x AF x ABS-d
				CS SA ABS-d AF EF ED EV BW AT-NC AT-C CFsoil	Chemical Concentration in Soil Surface area for contact Dermal absorption factor-VOCs Adherence factor Exposure frequency Exposure duration Event Frequency Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 3,527 chemical-specific 0.07 14 20 1 80 7,300 25,550 1.0E-06	mg/kg cm ² /day unitless mg/cm ² day/yr yr events/day kg days days kg/mg	See Table 3s BPJ USEPA 2004 USEPA, 2018 BPJ BPJ EPA, 2001 USEPA, 2011 USEPA, 2011 USEPA, 2011 USEPA 1989	Dermal Absorbed Dose (DAD) (mg/kg-day) = (DA-event x EF x ED x EV x SA) / (AT x BW) where Absorbed Dose per Event (DA-event) (mg/cm ² -event) = CS x CF x AF x ABS-d
	Resident	Adult	Soil	CS SA ABS-d AF EF ED EV BW AT-NC AT-C CFsoil	Chemical Concentration in Soil Surface area for contact Dermal absorption factor-VOCs Adherence factor Exposure frequency Exposure duration Event Frequency Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 6,032 chemical-specific 0.07 270 20 1 80 7,300 25,550 1.0E-06	mg/kg cm ² /day unitless mg/cm ² day/yr yr events/day kg days days kg/mg	See Table 3s USEPA, 2018 USEPA 2004 USEPA, 2018 MDEQ, 2016 USEPA, 2011 EPA, 2001 USEPA, 2011 USEPA, 2011 USEPA, 2011 USEPA 1989	Dermal Absorbed Dose (DAD) (mg/kg-day) = (DA-event x EF x ED x EV x SA) / (AT x BW) where Absorbed Dose per Event (DA-event) (mg/cm ² -event) = CS x CF x AF x ABS-d
				CS SA ABS-d AF EF ED EV BW AT-NC AT-C CFsoil	Chemical Concentration in Soil Surface area for contact Dermal absorption factor-VOCs Adherence factor Exposure frequency Exposure duration Event Frequency Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 2,373 chemical-specific 0.2 270 6 1 15 2190 25550 1.0E-06	mg/kg cm ² /day unitless mg/cm ² day/yr yr events/day kg days days kg/mg	See Table 3s USEPA, 2018 USEPA 2004 USEPA, 2018 MDEQ, 2016 USEPA, 2011 EPA, 2001 USEPA, 2011 USEPA, 2011 USEPA, 2011 USEPA 1989	Dermal Absorbed Dose (DAD) (mg/kg-day) = (DA-event x EF x ED x EV x SA) / (AT x BW) where Absorbed Dose per Event (DA-event) (mg/cm ² -event) = CS x CF x AF x ABS-d

TABLE 4-1
Exposure Equations and Assumptions - Current/Future Scenario: Soil and Sediment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Surface Soil/Sediment

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name
Dermal	Recreationist (Floater)	Adolescent (6-16 years)	Soil/ Sediment	CS SA ABS-d AF EF ED EV BW AT-NC AT-C CFsoil	Chemical Concentration in Soil Surface area for contact Dermal absorption factor-VOCs Adherence factor Exposure frequency Exposure duration Event Frequency Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 19,652 chemical-specific 0.07 10 10 1 80 3,650 25,550 1.0E-06	mg/kg cm ² /day unitless mg/cm ² day/yr yr events/day kg days days kg/mg	See Table 3s USEPA, 2018 USEPA 2004 USEPA, 2018 BPJ USEPA, 2011 EPA, 2001 USEPA, 2011 USEPA, 2011 USEPA, 1989	Dermal Absorbed Dose (DAD) (mg/kg-day) = (DA-event x EF x ED x EV x SA) / (AT x BW) where Absorbed Dose per Event (DA-event) (mg/cm ² -event) = CS x CF x AF x ABS-d
	Recreationist (Floater)	Adult	Soil/ Sediment	CS SA ABS-d AF EF ED EV BW AT-NC AT-C CFsoil	Chemical Concentration in Soil Surface area for contact Dermal absorption factor-VOCs Adherence factor, adult Exposure frequency Exposure duration Event Frequency Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 19,652 chemical-specific 0.07 10 20 1 80 7300 25550 1.0E-06	mg/kg cm ² /day unitless mg/cm ² day/yr yr events/day kg days days kg/mg	See Table 3s USEPA, 2018 USEPA 2004 USEPA, 2018 BPJ USEPA, 2011 EPA, 2001 USEPA, 2011 USEPA, 2011 USEPA, 1989	Dermal Absorbed Dose (DAD) (mg/kg-day) = (DA-event x EF x ED x EV x SA) / (AT x BW) where Absorbed Dose per Event (DA-event) (mg/cm ² -event) = CS x CF x AF x ABS-d
	Recreationist (Fisher)	Adult	Soil/ Sediment	CS SA ABS-d AF EF ED EV BW AT-NC AT-C CFsoil	Chemical Concentration in Soil Surface area for contact Dermal absorption factor-VOCs Adherence factor, adult Exposure frequency Exposure duration Event Frequency Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 6,032 chemical-specific 0.07 10 20 1 80 7,300 25,550 1.0E-06	mg/kg cm ² /day unitless mg/cm ² day/yr yr events/day kg days days kg/mg	See Table 3s USEPA, 2018 USEPA 2004 USEPA, 2018 BPJ USEPA, 2011 EPA, 2001 USEPA, 2011 USEPA, 2011 USEPA, 1989	Dermal Absorbed Dose (DAD) (mg/kg-day) = (DA-event x EF x ED x EV x SA) / (AT x BW) where Absorbed Dose per Event (DA-event) (mg/cm ² -event) = CS x CF x AF x ABS-d
	Trespasser	Adolescent (6-16 yrs)	Soil/ Sediment	CS SA ABS-d AF EF ED EV BW AT-NC AT-C CFsoil	Chemical Concentration in Soil Surface area for contact Dermal absorption factor-VOCs Adherence factor Exposure frequency Exposure duration Event Frequency Body weight Averaging time - noncancer Averaging time - cancer Conversion factor	See Table 3s 19,652 chemical-specific 0.07 50 10 1 80 3,650 25,550 1.0E-06	mg/kg cm ² /day unitless mg/cm ² day/yr yr events/day kg days days kg/mg	See Table 3s USEPA, 2018 USEPA 2004 USEPA, 2018 BPJ USEPA, 2011 EPA, 2001 USEPA, 2011 USEPA, 2011 USEPA, 1989	Dermal Absorbed Dose (DAD) (mg/kg-day) = (DA-event x EF x ED x EV x SA) / (AT x BW) where Absorbed Dose per Event (DA-event) (mg/cm ² -event) = CS x CF x AF x ABS-d

Footnotes:

a/ mg/d = milligrams per day; yr = year; kg = kilogram; cm²/day = square centimeter per day; mg/cm² = milligrams per square centimeter;

hr/day = hours per day

b/ Refer to text for complete reference citations and discussion of best professional judgment (BPJ) parameter values.

TABLE 4-2
Exposure Equations and Assumptions - Current/Future Scenario: Soil to Air
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Air and Airborne Particulate

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name
Inhalation	Industrial Worker	Adult	Airborne Particulate and Vapors	CS	Chemical Concentration in Soil	See Table 3s	mg/kg	See Table 3s	Intake (mg/m3) = $CS_{soil} \times (1/VF + 1/PEF) \times ET \times EF \times ED$ AT
				ET	Exposure time	8	hr/day	USEPA, 2018	
				EF	Exposure frequency	187	day/yr	MDEQ, 2017	
				ED	Exposure duration	25	yr	USEPA, 2018	
				AT-NC	Averaging time - noncancer	9,125	days	USEPA, 2018	
				AT-C	Averaging time - cancer	25,550	days	USEPA, 2018	
				PEF	Particulate Emissions Factor	1.36E+09	m3/kg	USEPA, 2018	
				VF	Volatilization factor	chemical-specific	m3/kg	MDEQ, 2017	
				CFair	Conversion factor for carcinogenic risk calculations	1.00E+03	ug/mg	USEPA, 2018	
				CFday	Conversion factor for time	1/24	days/hr	EPA, 2009	
				CFsoil	Conversion factor	1.0E-06	kg/mg	USEPA 1989	
	Construction Worker	Adult	Airborne Particulate and Vapors	CS	Chemical Concentration in Soil	See Table 3s	mg/kg	See Table 3s	Intake (mg/m3) = $CS_{soil} \times (1/VF + 1/PEF) \times ET \times EF \times ED$ AT
				ET	Exposure time	8	hr/day	USEPA, 2018	
				EF	Exposure frequency	124	day/yr	MDEQ, 2016	
				ED	Exposure duration	1	yr	USEPA, 2018	
				AT-NC	Averaging time - noncancer	80	days	USEPA, 2018	
				AT-C	Averaging time - cancer	365	days	USEPA, 2018	
				PEF	Particulate Emissions Factor	1.36E+09	m3/kg	MDEQ, 2017	
				VF	Volatilization factor	chemical-specific	m3/kg	USEPA, 2018	
				CFair	Conversion factor for carcinogenic risk calculations	1.00E+03	ug/mg	EPA, 2009	
				CFday	Conversion factor for time	1/24	days/hr	USEPA 1989	
				CFsoil	Conversion factor	1.0E-06	kg/mg		
	Stormwater Management Worker	Adult	Airborne Particulate and Vapors	CS	Chemical Concentration in Soil	See Table 3s	mg/kg	See Table 3s	Intake (mg/m3) = $CS_{soil} \times (1/VF + 1/PEF) \times ET \times EF \times ED$ AT
				ET	Exposure time	1	hr/day	BPJ	
				EF	Exposure frequency	38	day/yr	BPJ	
				ED	Exposure duration	25	yr	USEPA, 2018	
				AT-NC	Averaging time - noncancer	9,125	days	USEPA, 2018	
				AT-C	Averaging time - cancer	25,550	days	USEPA, 2018	
				PEF	Particulate Emissions Factor	1.360E+09	m3/kg	MDEQ, 2017	
				VF	Volatilization factor	chemical-specific	m3/kg	USEPA, 2018	
				CFair	Conversion factor for carcinogenic risk calculations	1.00E+03	ug/mg	EPA, 2009	
				CFday	Conversion factor for time	1/24	days/hr	USEPA 1989	
				CFsoil	Conversion factor	1.0E-06	kg/mg		
	Recreational Trespasser (ATV)	Adult	Airborne Particulate and Vapors	CS	Chemical Concentration in Soil	See Table 3s	mg/kg	See Table 3s	Intake (mg/m3) = $CS_{soil} \times (1/VF + 1/PEF) \times ET \times EF \times ED$ AT
				ET	Exposure time	1	hr/day	BPJ	
				EF	Exposure frequency	9	day/yr	BPJ	
				ED	Exposure duration	20	yr	USEPA, 2018	
				AT-NC	Averaging time - noncancer	7,300	days	USEPA, 2018	
				AT-C	Averaging time - cancer	25,550	days	USEPA, 2018	
				PEF	Particulate Emissions Factor	8.5E+05	m3/kg	CDPHE, 2011	
				VF	Volatilization factor	chemical-specific	m3/kg	USEPA, 2018	
				CFair	Conversion factor for carcinogenic risk calculations	1.00E+03	ug/mg	EPA, 2009	
				CFday	Conversion factor for time	1/24	days/hr	USEPA 1989	
				CFsoil	Conversion factor	1.00E-06	kg/mg		

TABLE 4-2
Exposure Equations and Assumptions - Current/Future Scenario: Soil to Air
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Air and Airborne Particulate

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name
Inhalation	Recreational Trespasser (Hunter)	Adult	Airborne Particulate and Vapors	CS ET EF ED AT-NC AT-C PEF VF CFair CFday CFSoil	Chemical Concentration in Soil Exposure time Exposure frequency Exposure duration Averaging time - noncancer Averaging time - cancer Particulate Emissions Factor Volatilization factor Conversion factor for carcinogenic risk calculations Conversion factor for time Conversion factor	See Table 3s 8 14 20 7,300 25,550 1.360E+09 chemical-specific 1.00E+03 1/24 1.0E-06	mg/kg hr/day day/yr yr days days m3/kg m3/kg ug/mg days/hr kg/mg	See Table 3s BPJ BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018 MDEQ, 2017 USEPA, 2018 EPA, 2009 USEPA 1989	Intake (mg/m3) = $CS_{soil} \times (1/VF + 1/PEF) \times ET \times EF \times ED$ AT
	Recreationist (Floater)	Adolescent (6-16 years)	Airborne Particulate and Vapors	CS ET EF ED AT-NC AT-C PEF VF CFair CFday CFSoil	Chemical Concentration in Soil Exposure time Exposure frequency Exposure duration Averaging time - noncancer Averaging time - cancer Particulate Emissions Factor Volatilization factor Conversion factor for carcinogenic risk calculations Conversion factor for time Conversion factor	See Table 3s 1 10 10 3,650 25,550 1.360E+09 chemical-specific 1.00E+03 1/24 1.0E-06	mg/kg hr/day day/yr yr days days m3/kg m3/kg mg/ug days/hr kg/mg	See Table 3s BPJ BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018 MDEQ, 2017 EPA, 2009 EPA, 2009 USEPA 1989	Intake (mg/m3) = $CS_{soil} \times (1/VF + 1/PEF) \times ET \times EF \times ED$ AT
	Recreationist (Floater)	Adult	Airborne Particulate and Vapors	CS ET EF ED AT-NC AT-C PEF VF CFair CFday CFSoil	Chemical Concentration in Soil Exposure time Exposure frequency Exposure duration Averaging time - noncancer Averaging time - cancer Particulate Emissions Factor Volatilization factor Conversion factor for carcinogenic risk calculations Conversion factor for time Conversion factor	See Table 3s 1 10 20 7,300 25,550 1.360E+09 chemical-specific 1.00E+03 1/24 1.0E-06	mg/kg hr/day day/yr yr days days m3/kg m3/kg mg/ug days/hr kg/mg	See Table 3s BPJ BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018 MDEQ, 2017 EPA, 2009 EPA, 2009 USEPA 1989	Intake (mg/m3) = $CS_{soil} \times (1/VF + 1/PEF) \times ET \times EF \times ED$ AT
	Recreationist (Fisher)	Adult	Airborne Particulate and Vapors	CS ET EF ED AT-NC AT-C PEF VF CFair CFday CFSoil	Chemical Concentration in Soil Exposure time Exposure frequency Exposure duration Averaging time - noncancer Averaging time - cancer Particulate Emissions Factor Volatilization factor Conversion factor for carcinogenic risk calculations Conversion factor for time Conversion factor	See Table 3s 1 10 20 7,300 25,550 1.360E+09 chemical-specific 1.00E+03 1/24 1.0E-06	mg/kg hr/day day/yr yr days days m3/kg m3/kg mg/ug days/hr kg/mg	See Table 3s BPJ BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018 MDEQ, 2017 EPA, 2009 EPA, 2009 USEPA 1989	Intake (mg/m3) = $CS_{soil} \times (1/VF + 1/PEF) \times ET \times EF \times ED$ AT

TABLE 4-2
Exposure Equations and Assumptions - Current/Future Scenario: Soil to Air
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Soil
Exposure Medium: Air and Airborne Particulate

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name
Inhalation	Resident	Adult	Airborne Particulate and Vapors	CS	Chemical Concentration in Soil	See Table 3s	mg/kg	See Table 3s	Intake (mg/m3) = $CS_{soil} \times (1/VF + 1/PEF) \times ET \times EF \times ED$ AT
				ET	Exposure time	24	hr/day	USEPA, 2018	
				EF	Exposure frequency	270	day/yr	BPJ	
				ED	Exposure duration	20	yr	USEPA, 2018	
				AT-NC	Averaging time - noncancer	7,300	days	USEPA, 2018	
				AT-C	Averaging time - cancer	25,550	days	USEPA, 2018	
				PEF	Particulate Emissions Factor	1.360E+09	m3/kg	USEPA, 2018	
				VF	Volatilization factor	chemical-specific	m3/kg	MDEQ, 2017	
				CFair	Conversion factor for carcinogenic risk calculations	1.00E+03	ug/mg	USEPA, 2018	
				CFday	Conversion factor for time	1/24	days/hr	EPA, 2009	
				CFsoil	Conversion factor	1.00E-06	kg/mg	USEPA 1989	
	Resident	Child	Airborne Particulate and Vapors	CS	Chemical Concentration in Soil	See Table 3s	mg/kg	See Table 3s	Intake (mg/m3) = $CS_{soil} \times (1/VF + 1/PEF) \times ET \times EF \times ED$ AT
				ET	Exposure time	24	hr/day	USEPA, 2018	
				EF	Exposure frequency	270	day/yr	BPJ	
				ED	Exposure duration	6	yr	USEPA, 2018	
				AT-NC	Averaging time - noncancer	2,190	days	USEPA, 2018	
				AT-C	Averaging time - cancer	25,550	days	USEPA, 2018	
				PEF	Particulate Emissions Factor	1.360E+09	m3/kg	USEPA, 2018	
				VF	Volatilization factor	chemical-specific	m3/kg	MDEQ, 2017	
				CFair	Conversion factor for carcinogenic risk calculations	1.00E+03	ug/mg	USEPA, 2018	
				CFday	Conversion factor for time	1/24	days/hr	EPA, 2009	
				CFsoil	Conversion factor	1.00E-06	kg/mg	USEPA 1989	
	Trespasser	Adolescent (6-16 years)	Airborne Particulate and Vapors	CS	Chemical Concentration in Soil	See Table 3s	mg/kg	See Table 3s	Intake (mg/m3) = $CS_{soil} \times (1/VF + 1/PEF) \times ET \times EF \times ED$ AT
				ET	Exposure time	1	hr/day	BPJ	
				EF	Exposure frequency	50	day/yr	MDEQ, 2017	
				ED	Exposure duration	10	yr	USEPA, 2018	
				AT-NC	Averaging time - noncancer	3,650	days	USEPA, 2018	
				AT-C	Averaging time - cancer	25,550	days	USEPA, 2018	
				PEF	Particulate Emissions Factor	1.360E+09	m3/kg	MDEQ, 2017	
				VF	Volatilization factor	chemical-specific	m3/kg	EPA, 2009	
				CFair	Conversion factor for carcinogenic risk calculations	1.00E+03	mg/ug	EPA, 2009	
				CFday	Conversion factor for time	1/24	days/hr	EPA, 2009	
				CFsoil	Conversion factor	1.00E-06	kg/mg	USEPA 1989	

Footnotes:

a/ mg/d = milligrams per day; yr = year; kg = kilogram; cm²/day = square centimeter per day; mg/cm² = milligrams per square centimeter;

hr/day = hours per day

b/ Refer to text for complete reference citations and discussion of best professional judgment (BPJ) parameter values.

TABLE 4-3
Exposure Equations and Assumptions - Current/Future Scenario: Surface Water
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name
Ingestion	Stormwater Management Worker	Adult	Surface Water	EPCsw IRsw EF ED EV ET CF BW AT-n AT-c	Chemical Concentration in Surface water Surface water intake rate Exposure frequency Exposure duration Events per day Exposure time per event Conversion factor Body weight Averaging time (noncancer endpoint) Averaging time (cancer endpoint)	See Table 3s 0.071 38 25 1 1 1.0E-03 80 9125 25550	µg/l l/hr day/yr yr events/day hr/event mg/µg kg days days	See Table 3s USEPA, 2018 BPJ USEPA, 2018 BPJ USEPA, 2018 BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018	ADD _{sw} or LADD _{sw} (mg/kg-day) = <u>EPC_{sw} x IR_{sw} x EF x ED x EV x ET x CF</u> BW x AT
	Recreational Trespasser (ATV)	Adult	Surface Water	EPCsw IRsw EF ED EV ET CF BW AT-n AT-c	Chemical Concentration in Surface Water Surface water intake rate Exposure frequency Exposure duration Events per day Exposure time per event Conversion factor Body weight Averaging time (noncancer endpoint) Averaging time (cancer endpoint)	See Table 3s 0.071 9 20 1 1 1.0E-03 80 7,300 25,550	µg/l l/hr day/yr yr events/day hr/event mg/µg kg days days	See Table 3s USEPA, 2018 BPJ USEPA, 2018 BPJ USEPA, 2018 BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018	ADD _{sw} or LADD _{sw} (mg/kg-day) = <u>EPC_{sw} x IR_{sw} x EF x ED x EV x ET x CF</u> BW x AT
	Recreational Trespasser (Hunter)	Adult	Surface Water	EPCsw IRsw EF ED EV ET CF BW AT-n AT-c	Chemical Concentration in Surface Water Surface water intake rate Exposure frequency Exposure duration Events per day Exposure time per event Conversion factor Body weight Averaging time (noncancer endpoint) Averaging time (cancer endpoint)	See Table 3s 0.071 14 20 1 1 1.0E-03 80 7,300 25550	µg/l l/hr day/yr yr events/day hr/event mg/µg kg days days	See Table 3s USEPA, 2018 BPJ USEPA, 2018 BPJ USEPA, 2018 BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018	ADD _{sw} or LADD _{sw} (mg/kg-day) = <u>EPC_{sw} x IR_{sw} x EF x ED x EV x ET x CF</u> BW x AT
	Recreationist (Floater)	Adolescent (6-16 years)	Surface Water	EPCsw IRsw EF ED EV ET CF BW AT-n AT-c	Chemical Concentration in Surface Water Surface water intake rate Exposure frequency Exposure duration Events per day Exposure time per event Conversion factor Body weight Averaging time (noncancer endpoint) Averaging time (cancer endpoint)	See Table 3s 0.071 10 10 1 1 1.0E-03 80 3,650 25550	µg/l l/hr day/yr yr events/day hr/event mg/µg kg days days	See Table 3s USEPA, 2018 BPJ USEPA, 2018 BPJ USEPA, 2018 BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018	ADD _{sw} or LADD _{sw} (mg/kg-day) = <u>EPC_{sw} x IR_{sw} x EF x ED x EV x ET x CF</u> BW x AT

TABLE 4-3
Exposure Equations and Assumptions - Current/Future Scenario: Surface Water
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name
Ingestion	Recreationist (Floater)	Adult	Surface Water	EPCsw	Chemical Concentration in Surface Water	See Table 3s 0.071 10 20 1 1 1.0E-03 80 7300 25550	$\mu\text{g/l}$ l/hr day/yr yr events/day hr/event mg/ μg kg days days	See Table 3s USEPA, 2018 BPJ USEPA, 2018 USEPA, 2018 BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018	ADD _{sw} or LADD _{sw} (mg/kg-day) = $\underline{\underline{\text{EPC}_{sw} \times IR_{sw} \times EF \times ED \times EV \times ET \times CF}} \\ \text{BW} \times \text{AT}$
				IRsw	Surface water intake rate				
				EF	Exposure frequency				
				ED	Exposure duration				
				EV	Events per day				
				ET	Exposure time per event				
				CF	Conversion factor				
				BW	Body weight				
				AT-n	Averaging time (noncancer endpoint)				
				AT-c	Averaging time (cancer endpoint)				
	Recreationist (Fisher)	Adult	Surface Water	EPCsw	Chemical Concentration in Surface Water				
				IRsw	Surface water intake rate				
				EF	Exposure frequency				
				ED	Exposure duration				
				EV	Events per day				
				ET	Exposure time per event				
				CF	Conversion factor				
				BW	Body weight				
				AT-n	Averaging time (noncancer endpoint)				
				AT-c	Averaging time (cancer endpoint)				
	Trespasser	Adolescent (6-16 years)	Surface Water	EPCsw	Chemical Concentration in Surface Water	See Table 3s 0.071 50 10 1 1 1.0E-03 80 3650 25550	$\mu\text{g/l}$ l/hr day/yr yr events/day hr/event mg/ μg kg days days	See Table 3s USEPA, 2018 BPJ USEPA, 2018 USEPA, 2018 BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018	ADD _{sw} or LADD _{sw} (mg/kg-day) = $\underline{\underline{\text{EPC}_{sw} \times IR_{sw} \times EF \times ED \times EV \times ET \times CF}} \\ \text{BW} \times \text{AT}$
	IRsw	Surface water intake rate							
	EF	Exposure frequency							
	ED	Exposure duration							
	EV	Events per day							
	ET	Exposure time per event							
	CF	Conversion factor							
	BW	Body weight							
	AT-n	Averaging time (noncancer endpoint)							
	AT-c	Averaging time (cancer endpoint)							

TABLE 4-3
Exposure Equations and Assumptions - Current/Future Scenario: Surface Water
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name
Dermal	Stormwater Management Worker	Adult	Surface Water	EPCsw EF ED EV ET SAsw BW FA Kp MW DFW-adj t _{event} t* B CF1 CF2 AT-n AT-c	Chemical concentration in surface water Exposure frequency Exposure duration Events per day Exposure time per event Skin surface area exposed to surface water Body weight Fraction absorbed Dermal permeability Molecular weight Recreator water dermal contact factor Lag time per event Time to reach steady-state Ratio of permeability through stratum corneum to permeability across viable epidermis Conversion factor Conversion factor Averaging time (noncancer endpoint) Averaging time (cancer endpoint)	See Table 3s 38 25 1 1 3,527 80 chemical-specific chemical-specific chemical-specific chemical-specific 41883 chemical-specific chemical-specific chemical-specific chemical-specific 1.0E-03 #REF! 9125 25550	µg/L days/year years events/day hr/event cm ² kg -- cm/hr g/mole cm ² -event/kg hr/event hr -- mg/µg L/cm ³ days days	See Table 3s BPJ USEPA, 2018 BPJ BPJ USEPA, 2018 USEPA, 2018 -- USEPA, 2018 USEPA, 2018 #REF! USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018	DADsw or LDADsw (mg/kg-day) = For inorganics: $EPC_{sw} \times K_p \times ET \times DFW_{rec-adj} \times CF1 \times CF2$ AT For organics if ET ≤ t*: $EPC_{sw} \times 2 \times FA \times K_p \times \sqrt{\frac{6 \times t_{event} \times ET}{\pi}} \times DFW_{rec-adj} \times CF1 \times CF2$ AT For organics if ET > t*: $EPC_{sw} \times \frac{1}{2} \times K_p \times \left[\frac{ET}{1+B} + 2 \times t_{event} \times \left(\frac{(1+3B+3B^2)}{(1+B)^2} \right) \right] \times DFW_{rec-adj} \times CF1 \times CF2$ AT
	Recreational Trespasser (ATV)	Adult	Surface Water	EPCsw EF ED EV ET SAsw BW FA Kp MW DFWrec-adj t _{event} t* B CF1 CF2 AT-n AT-c	Chemical concentration in surface water Exposure frequency Exposure duration Events per day Exposure time per event Skin surface area exposed to surface water Body weight Fraction absorbed Dermal permeability Molecular weight Water dermal contact factor Lag time per event Time to reach steady-state Ratio of permeability through stratum corneum to permeability across viable epidermis Conversion factor Conversion factor Averaging time (noncancer endpoint) Averaging time (cancer endpoint)	See Table 3s 9 20 1 1 3,527 80 chemical-specific chemical-specific chemical-specific chemical-specific 7936 chemical-specific chemical-specific chemical-specific chemical-specific 1.0E-03 #REF! 7300 25550	µg/L days/year years events/day hr/event cm ² kg -- cm/hr g/mole cm ² -event/kg hr/event hr -- mg/µg L/cm ³ days days	See Table 3s BPJ USEPA, 2018 BPJ BPJ USEPA, 2018 USEPA, 2018 -- USEPA, 2018 USEPA, 2018 #REF! USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018	DADsw or LDADsw (mg/kg-day) = For inorganics: $EPC_{sw} \times K_p \times ET \times DFW_{rec-adj} \times CF1 \times CF2$ AT For organics if ET ≤ t*: $EPC_{sw} \times 2 \times FA \times K_p \times \sqrt{\frac{6 \times t_{event} \times ET}{\pi}} \times DFW_{rec-adj} \times CF1 \times CF2$ AT For organics if ET > t*: $EPC_{sw} \times \frac{1}{2} \times K_p \times \left[\frac{ET}{1+B} + 2 \times t_{event} \times \left(\frac{(1+3B+3B^2)}{(1+B)^2} \right) \right] \times DFW_{rec-adj} \times CF1 \times CF2$ AT

TABLE 4-3
Exposure Equations and Assumptions - Current/Future Scenario: Surface Water
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name	
Dermal	Recreational Trespasser (Hunter)	Adult	Surface Water	EPCsw EF ED EV ET SAsw BW FA Kp MW DFWrec-adj t _{event} t* B CF1 CF2 AT-n AT-c	Chemical concentration in surface water Exposure frequency Exposure duration Events per day Exposure time per event Skin surface area exposed to surface water Body weight Fraction absorbed Dermal permeability Molecular weight Water dermal contact factor Lag time per event Time to reach steady-state Ratio of permeability through stratum corneum to permeability across viable epidermis Conversion factor Conversion factor Averaging time (noncancer endpoint) Averaging time (cancer endpoint)	See Table 3s 14 20 1 1 3,527 80 chemical-specific chemical-specific chemical-specific 12345 chemical-specific chemical-specific chemical-specific 1.0E-03 #REF! 7300 25550	µg/L days/year years events/day hr/event cm ² kg -- cm/hr g/mole cm ² -event/kg hr/event hr -- mg/µg L/cm ³ days days	See Table 3s BPJ USEPA, 2018 BPJ BPJ USEPA, 2018 USEPA, 2018 chemical-specific chemical-specific chemical-specific 1.0E-03 #REF! 7300 25550	See Table 3s BPJ USEPA, 2018 BPJ BPJ USEPA, 2018 USEPA, 2018 chemical-specific chemical-specific chemical-specific 1.0E-03 #REF! 7300 25550	DADsw or LDADsw (mg/kg-day) = For inorganics: $EPC_{sw} \times K_p \times ET \times DFW_{rec-adj} \times CF1 \times CF2$ AT For organics if ET ≤ t*: $EPC_{sw} \times 2 \times FA \times K_p \times \sqrt{\frac{6 \times t_{event} \times ET}{\pi}} \times DFW_{rec-adj} \times CF1 \times CF2$ AT For organics if ET > t*: $EPC_{sw} \times \frac{B}{(1+B)} \times K_p \times \left[\frac{ET}{(1+B)} + 2 \times t_{event} \times \left(\frac{(1+3B) + 3B^2}{(1+B)^2} \right) \right] \times DFW_{rec-adj} \times CF1 \times CF2$ AT
	Recreationist (Floater)	Adolescent (6-16 years)	Surface Water	EPCsw EF ED EV ET SAsw BW FA Kp MW DFWrec-adj t _{event} t* B CF1 CF2 AT-n AT-c	Chemical concentration in surface water Exposure frequency Exposure duration Events per day Exposure time per event Skin surface area exposed to surface water Body weight Fraction absorbed Dermal permeability Molecular weight Water dermal contact factor Lag time per event Time to reach steady-state Ratio of permeability through stratum corneum to permeability across viable epidermis Conversion factor Conversion factor Averaging time (noncancer endpoint) Averaging time (cancer endpoint)	See Table 3s 10 10 1 1 19652 80 chemical-specific chemical-specific chemical-specific 24565 chemical-specific chemical-specific chemical-specific 1.0E-03 #REF! 3650 25550	µg/L days/year years events/day hr/event cm ² kg -- cm/hr g/mole cm ² -event/kg hr/event hr -- mg/µg L/cm ³ days days	See Table 3s BPJ USEPA, 2018 BPJ BPJ USEPA, 2018 USEPA, 2018 chemical-specific chemical-specific chemical-specific 1.0E-03 #REF! 3650 25550	See Table 3s BPJ USEPA, 2018 BPJ BPJ USEPA, 2018 USEPA, 2018 chemical-specific chemical-specific chemical-specific 1.0E-03 #REF! 3650 25550	DADsw or LDADsw (mg/kg-day) = For inorganics: $EPC_{sw} \times K_p \times ET \times DFW_{rec-adj} \times CF1 \times CF2$ AT For organics if ET ≤ t*: $EPC_{sw} \times 2 \times FA \times K_p \times \sqrt{\frac{6 \times t_{event} \times ET}{\pi}} \times DFW_{rec-adj} \times CF1 \times CF2$ AT For organics if ET > t*: $EPC_{sw} \times \frac{B}{(1+B)} \times K_p \times \left[\frac{ET}{(1+B)} + 2 \times t_{event} \times \left(\frac{(1+3B) + 3B^2}{(1+B)^2} \right) \right] \times DFW_{rec-adj} \times CF1 \times CF2$ AT

TABLE 4-3
Exposure Equations and Assumptions - Current/Future Scenario: Surface Water
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name	
Dermal	Recreationist (Floater)	Adult	Surface Water	EPCsw EF ED EV ET SAsw BW FA Kp MW DFWrec-adj t _{event} t* B CF1 CF2 AT-n AT-c	Chemical concentration in surface water Exposure frequency Exposure duration Events per day Exposure time per event Skin surface area exposed to surface water Body weight Fraction absorbed Dermal permeability Molecular weight Water dermal contact factor Lag time per event Time to reach steady-state Ratio of permeability through stratum corneum to permeability across viable epidermis Conversion factor Conversion factor Averaging time (noncancer endpoint) Averaging time (cancer endpoint)	See Table 3s 10 20 1 1 19652 80 chemical-specific chemical-specific chemical-specific 49130 chemical-specific chemical-specific chemical-specific 1.0E-03 #REF! 7300 25550	µg/L days/year years events/day hr/event cm ² kg -- cm/hr g/mole cm ² -event/kg hr/event hr -- mg/µg L/cm ³ days days	See Table 3s BPJ USEPA, 2018 BPJ BPJ USEPA, 2018 USEPA, 2018 chemical-specific chemical-specific chemical-specific 49130 chemical-specific chemical-specific chemical-specific 1.0E-03 #REF! 7300 25550	See Table 3s BPJ USEPA, 2018 BPJ BPJ USEPA, 2018 USEPA, 2018 chemical-specific chemical-specific chemical-specific 49130 chemical-specific chemical-specific chemical-specific 1.0E-03 #REF! 7300 25550	DADsw or LDADsw (mg/kg-day) = For inorganics: $EPC_{sw} \times K_p \times ET \times DFW_{rec-adj} \times CF1 \times CF2$ AT For organics if ET ≤ t*: $\frac{EPC_{sw} \times 2 \times FA \times K_p \times \sqrt{\frac{6 \times t_{event} \times ET}{\pi}} \times DFW_{rec-adj} \times CF1 \times CF2}{AT}$ For organics if ET > t*: $\frac{EPC_{sw} \times FA \times K_p \times \left[\frac{ET}{1+B} + 2 \times t_{event} \times \left(\frac{(1+3B+3B^2)}{(1+B)^2} \right) \right] \times DFW_{rec-adj} \times CF1 \times CF2}{AT}$
	Recreationist (Fisher)	Adult	Surface Water	EPCsw EF ED EV ET SAsw BW FA Kp MW DFWrec-adj t _{event} t* B CF1 CF2 AT-n AT-c	Chemical concentration in surface water Exposure frequency Exposure duration Events per day Exposure time per event Skin surface area exposed to surface water Body weight Fraction absorbed Dermal permeability Molecular weight Recreator water dermal contact factor Lag time per event Time to reach steady-state Ratio of permeability through stratum corneum to permeability across viable epidermis Conversion factor Conversion factor Averaging time (noncancer endpoint) Averaging time (cancer endpoint)	See Table 3s 10 20 1 1 1 6032 80 chemical-specific chemical-specific chemical-specific 15080 chemical-specific chemical-specific chemical-specific 1.0E-03 #REF! 7300 25550	µg/L days/year years events/day hr/event cm ² kg -- cm/hr g/mole cm ² -event/kg hr/event hr -- mg/µg L/cm ³ days days	See Table 3s BPJ USEPA, 2018 BPJ BPJ USEPA, 2018 USEPA, 2018 chemical-specific chemical-specific chemical-specific 15080 chemical-specific chemical-specific chemical-specific 1.0E-03 #REF! 7300 25550	See Table 3s BPJ USEPA, 2018 BPJ BPJ USEPA, 2018 USEPA, 2018 chemical-specific chemical-specific chemical-specific 15080 chemical-specific chemical-specific chemical-specific 1.0E-03 #REF! 7300 25550	DADsw or LDADsw (mg/kg-day) = For inorganics: $EPC_{sw} \times K_p \times ET \times DFW_{rec-adj} \times CF1 \times CF2$ AT For organics if ET ≤ t*: $\frac{EPC_{sw} \times 2 \times FA \times K_p \times \sqrt{\frac{6 \times t_{event} \times ET}{\pi}} \times DFW_{rec-adj} \times CF1 \times CF2}{AT}$ For organics if ET > t*: $\frac{EPC_{sw} \times FA \times K_p \times \left[\frac{ET}{1+B} + 2 \times t_{event} \times \left(\frac{(1+3B+3B^2)}{(1+B)^2} \right) \right] \times DFW_{rec-adj} \times CF1 \times CF2}{AT}$

TABLE 4-3
Exposure Equations and Assumptions - Current/Future Scenario: Surface Water
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name
Dermal	Trespasser	Adolescent (6-16 yrs)	Surface Water	EPCsw EF ED EV ET SAsw BW FA Kp MW DFWrec-adj t _{event} t* B CF1 CF2 AT-n AT-c	Chemical concentration in surface water Exposure frequency Exposure duration Events per day Exposure time per event Skin surface area exposed to surface water Body weight Fraction absorbed Dermal permeability Molecular weight Water dermal contact factor Lag time per event Time to reach steady-state Ratio of permeability through stratum corneum to permeability across viable epidermis Conversion factor Conversion factor Averaging time (noncancer endpoint) Averaging time (cancer endpoint)	See Table 3s 50 10 1 1 19652 80 chemical-specific chemical-specific chemical-specific 122825 chemical-specific chemical-specific chemical-specific 1.0E-03 #REF! 3650 25550	µg/L days/year years events/day hr/event cm ² kg -- cm/hr g/mole cm ² -event/kg hr/event hr -- mg/µg L/cm ³ days days	See Table 3s BPJ USEPA, 2018 BPJ BPJ USEPA, 2018 USEPA, 2018 -- USEPA, 2018 USEPA, 2018	DADsw or LDADsw (mg/kg-day) = For inorganics: $EPC_{sw} \times K_p \times ET \times DFW_{rec-adj} \times CF1 \times CF2$ AT For organics if ET ≤ t*: $\frac{EPC_{sw} \times 2 \times FA \times K_p \times \sqrt{\frac{6 \times t_{event} \times ET}{\pi}} \times DFW_{rec-adj} \times CF1 \times CF2}{AT}$ For organics if ET > t*: $\frac{EPC_{sw} \times FA \times K_p \times \left[\frac{ET}{1+B} + 2 \times t_{event} \times \left(\frac{(1+3B+3B^2)}{(1+B)^2} \right) \right] \times DFW_{rec-adj} \times CF1 \times CF2}{AT}$

Footnotes:

a/ mg/d = milligrams per day; yr = year; kg = kilogram; cm²/day = square centimeter per day; mg/cm² = milligrams per square centimeter;

hr/day = hours per day

b/ Refer to text for complete reference citations and discussion of best professional judgment (BPJ) parameter values.

TABLE 4-4
Exposure Equations and Assumptions - Current/Future Scenario: Groundwater
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Tapwater

TABLE 4-4
Exposure Equations and Assumptions - Current/Future Scenario: Groundwater
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Tapwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name
Dermal	Resident	Child	Tapwater	EPCgw EF ED EV ET SAgw BW FA Kp MW DFW-adj t _{event} t [*] B CF1 CF2 AT-n AT-c	Chemical Concentration in Groundwater Exposure frequency Exposure duration Events per day Exposure time per event Skin surface area exposed to groundwater Body weight Fraction absorbed Dermal permeability Molecular weight Water dermal contact factor Lag time per event Time to reach steady-state Ratio of permeability through stratum corneum to permeability across viable epidermis Conversion factor Conversion factor Averaging time (noncancer endpoint) Averaging time (cancer endpoint)	See Table 3s 350 6 1 0.54 6365 15 chemical-specific chemical-specific chemical-specific 891100 chemical-specific chemical-specific chemical-specific #REF! #REF! 2190 25550	µg/L days/year years events/day hr/event cm ² kg — cm/hr g/mole cm ² -event/kg hr/event hr — mg/µg L/cm ³ days days	See Table 3s USEPA, 2018 USEPA, 2018	DADgw or LDADgw (mg/kg-day) = For inorganics: $\frac{EPC_{gw} \times K_p \times ET \times DFW_{rec-adj} \times CF1 \times CF2}{AT}$ For organics if ET ≤ t [*] : $\frac{EPC_{gw} \times 2 \times FA \times K_p \times \sqrt{\frac{6 \times t_{event} \times ET}{\pi}} \times DFW_{rec-adj} \times CF1 \times CF2}{AT}$ For organics if ET > t [*] : $\frac{EPC_{gw} \times FA \times K_p \times \left[\frac{ET}{1+B} + 2 \times t_{event} \times \left(\frac{(1+3B+3B^2)}{(1+B)^2} \right) \right] \times DFW_{rec-adj} \times CF1 \times CF2}{AT}$

Footnotes:

a/ mg/d = milligrams per day; yr = year; kg = kilogram; cm²/day = square centimeter per day; mg/cm² = milligrams per square centimeter;
hr/day = hours per day

b/ Refer to text for complete reference citations and discussion of best professional judgment (BPJ) parameter values.

TABLE 4-5
Exposure Equations and Assumptions - Current/Future Scenario: Fish
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Fish

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name
Ingestion	Recreationist (Fisher)	Adult	Fish	Cfish MR IR _{fish} EF ED EV ET CF BW AT-n AT-c	Chemical Concentration in Fish Migration ratio Fish intake rate Exposure frequency Exposure duration Events per day Exposure time per event Conversion factor Body weight Averaging time (noncancer endpoint) Averaging time (cancer endpoint)	See Table 3s 0.1 12,971 10 20 1 1 1.0E-06 80 7300 25550	mg/kg unitless mg/day day/yr yr events/day hr/event kg/mg kg days days	See Table 3s BPJ BPJ BPJ USEPA, 2017 USEPA, 2017 USEPA, 2017 USEPA, 2017 USEPA, 2017 USEPA, 2017 USEPA, 2017 USEPA, 2017	ADD_{fish} or $LADD_{fish}$ (mg/kg-day) = $C_{fish} \times MR \times IR_{fish} \times EF \times ED \times EV \times ET \times CF$ $BW \times AT$

Footnotes:

a/ mg/d = milligrams per day; yr = year; kg = kilogram; cm²/day = square centimeter per day; mg/cm² = milligrams per square centimeter;
hr/day = hours per day

b/ Refer to text for complete reference citations and discussion of best professional judgment (BPJ) parameter values.

TABLE 4-6
Exposure Equations and Assumptions - Current/Future Scenario: Hunter Uptake through Venison
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Scenario Timeframe: Current/Future
Medium: Deer
Exposure Medium: Venison

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Parameter Value	Units (a)	Rationale/Reference (b)	Intake Equation/Model Name
Ingestion	Hunter	Adult	Deer	Cv Ir _v EF ED CF BW AT-n AT-c	Chemical Concentration in Venison Venison intake rate Exposure frequency Exposure duration Conversion factor Body weight Averaging time (noncancer endpoint) Averaging time (cancer endpoint)	See Table 3s 0.013 14 20 1.0E-06 80 7300 25550	mg/kg ww kg ww/day day/yr yr kg/mg kg days days	Refer to text (c) BPJ BPJ USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018 USEPA, 2018	ADD _{venison} or LADD _{venison} (mg/kg-day) = $\frac{Cv \times Ir_v \times EF \times ED}{BW \times AT}$

Footnotes:

a/ mg/d = milligrams per day; yr = year; kg = kilogram; cm²/day = square centimeter per day; mg/cm² = milligrams per square centimeter;
 hr/day = hours per day

b/ Refer to text for complete reference citations and discussion of best professional judgment (BPJ) parameter values.

c/ Refer to text for discussion of calculation of chemical concentration in deer.

Table 4-7
Chemical-Specific Parameters
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Footnotes:

a/ USEPA = US Environmental Protection Agency.

b/ USEPA, 2018

USEPA. (2018) Regional Screening Levels, May 2018 update

TABLE 5-1
Non-Cancer Toxicity Data (Oral/Dermal)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

COC	CAS No.	Chronic Oral RfD Value (a) (mg/kg-day)	Oral to Dermal Adjustment Factor	Chronic Oral to Dermal Adjustment Factor Source (b)	Adjusted Dermal RfD Value (mg/kg-day)	Chronic Primary Target Organ	Source (c)
Aluminum	7429-90-5	1.0E+00	1.0E+00	USEPA, 2018	1.0E+00	Neurological	USEPA (P)
Antimony	7440-36-0	4.0E-04	1.5E-01	USEPA, 2018	6.0E-05	Whole body	USEPA (I)
Arsenic	7440-38-2	3.0E-04	1.0E+00	USEPA, 2018	3.0E-04	Skin and blood	USEPA (I)
Barium	7440-39-3	2.0E-01	7.0E-02	USEPA, 2018	1.4E-02	Neurological	USEPA (I)
Beryllium	7440-41-7	2.0E-03	7.0E-03	USEPA, 2018	1.4E-05	Gastrointestinal	USEPA (I)
Cadmium (Diet)	7440-43-9-d	1.0E-03	2.5E-02	USEPA, 2018	2.5E-05	Urinary	USEPA (I)
Cadmium (Water)	7440-43-9	5.0E-04	5.0E-02	USEPA, 2018	2.5E-05	Urinary	USEPA (I)
Chromium, Trivalent	16065-83-1	1.5E+00	1.3E-02	USEPA, 2018	2.0E-02	NA	USEPA (I)
Chromium, Hexavalent	18540-29-9	3.0E-03	2.5E-02	USEPA, 2018	7.5E-05	NA	USEPA (I)
Cobalt	7440-48-4	3.0E-04	1.0E+00	USEPA, 2018	3.0E-04	Thyroid	USEPA (P)
Copper	7440-50-8	4.0E-02	1.0E+00	USEPA, 2018	4.0E-02	Gastrointestinal system	USEPA (H)
Iron	7439-89-6	7.0E-01	1.0E+00	USEPA, 2018	7.0E-01	GI tract	USEPA (P)
Manganese (Diet)	7439-96-5-d	1.4E-01	1.0E+00	USEPA, 2018	1.4E-01	Nervous	USEPA (I)
Manganese (Non-diet)	7439-96-5	2.4E-02	4.0E-02	USEPA, 2018	9.6E-04	Nervous	USEPA (S)
Mercury	7439-97-6	NA	1.0E+00	USEPA, 2018	NA	NA	NA
Nickel	7440-02-0	2.0E-02	4.0E-02	USEPA, 2018	8.0E-04	Body weight	USEPA (I)
Selenium	7782-49-2	5.0E-03	1.0E+00	USEPA, 2018	5.0E-03	Whole body	USEPA (I)
Silver	7440-22-4	5.0E-03	4.0E-02	USEPA, 2018	2.0E-04	Skin	USEPA (I)
Thallium	7440-28-0	1.0E-05	1.0E+00	USEPA, 2018	1.0E-05	Skin	USEPA (X)
Vanadium	7440-62-2	5.0E-03	2.6E-02	USEPA, 2018	1.3E-04	Dermal	USEPA (S)
Zinc	7440-66-6	3.0E-01	1.0E+00	USEPA, 2018	3.0E-01	Blood	USEPA (I)
Cyanide	57-12-5	6.0E-04	1.0E+00	USEPA, 2018	6.0E-04	Testes	USEPA (I)
Fluoride	16984-48-8	4.0E-02	1.0E+00	USEPA, 2018	4.0E-02	NA	USEPA (C)
2-Methylnaphthalene	91-57-6	4.0E-03	1.0E+00	USEPA, 2018	4.0E-03	Lungs	USEPA (I)
4-Chloroaniline	106-47-8	4.0E-03	1.0E+00	USEPA, 2018	4.0E-03	Spleen	USEPA (I)
Acenaphthene	83-32-9	6.0E-02	1.0E+00	USEPA, 2018	6.0E-02	Liver	USEPA (I)
Anthracene	120-12-7	3.0E-01	1.0E+00	USEPA, 2018	3.0E-01	NA	USEPA (I)
Benzaldehyde	100-52-7	1.0E-01	1.0E+00	USEPA, 2018	1.0E-01	Forestomach and kidney	USEPA (I)
Benzo(A)Anthracene	56-55-3	NA	1.0E+00	USEPA, 2018	NA		NA
Benzo(A)Pyrene	50-32-8	3.0E-04	1.0E+00	USEPA, 2018	3.0E-04	Developmental	USEPA (I)
Benzo(B)Fluoranthene	205-99-2	NA	1.0E+00	USEPA, 2018	NA		NA
Benzo(K)Fluoranthene	207-08-9	NA	1.0E+00	USEPA, 2018	NA		NA
Chrysene	218-01-9	NA	1.0E+00	USEPA, 2018	NA		NA
Dibenz(A,H)Anthracene	53-70-3	NA	1.0E+00	USEPA, 2018	NA		NA

TABLE 5-1
Non-Cancer Toxicity Data (Oral/Dermal)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

COC	CAS No.	Chronic Oral RfD Value (a) (mg/kg-day)	Oral to Dermal Adjustment Factor	Chronic Oral to Dermal Adjustment Factor Source (b)	Adjusted Dermal RfD Value (mg/kg-day)	Chronic Primary Target Organ	Source (c)
Dibenzofuran	132-64-9	1.0E-03	1.0E+00	USEPA, 2018	1.0E-03	NA	USEPA (X)
Fluoranthene	206-44-0	4.0E-02	1.0E+00	USEPA, 2018	4.0E-02	Whole body	USEPA (I)
Fluorene	86-73-7	4.0E-02	1.0E+00	USEPA, 2018	4.0E-02	Blood	USEPA (I)
Indeno(1,2,3-C,D)Pyrene	193-39-5	NA	1.0E+00	USEPA, 2018	NA		NA
Isophorone	78-59-1	2.0E-01	1.0E+00	USEPA, 2018	2.0E-01	Urinary	USEPA (I)
Naphthalene	91-20-3	2.0E-02	1.0E+00	USEPA, 2018	2.0E-02	Body weight	USEPA (I)
Pyrene	129-00-0	3.0E-02	1.0E+00	USEPA, 2018	3.0E-02	Kidney	USEPA (I)

Footnotes:

a/ mg/kg-day = milligrams per kilogram per day; NA = not available/not applicable

b/ Refer to text for citation

c/ OEHHA = California Office of Environmental Health Hazard Assessment -- Toxicity Criteria Database

DTSC = California Department of Toxic Substances Control -- toxicity criteria for TPH fractions

USEPA = U.S. Environmental Protection Agency

HHRA note 3 = Refer to Text for citation

PA DEP = Pennsylvania Department of Environmental Protection

Reg 9 PRG = US EPA Region 9 Preliminary Remediation Goal

A = Agency for Toxic Substance and Disease Registry

I = Integrated Risk Information System

C = Cal EPA

H = HEAST

P = PPRTV

S = USEPA (2018) for user guide Section 5

X = PPRTV Appendix

Refer to text for references.

Table 5-2
Non-Cancer Toxicity Data (Inhalation)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

COC	CAS No.	Chronic Inhalation RfC Value (a) mg/m ³	Primary Target Organ	Source (b)
Aluminum	7429-90-5	5.0E-03	Neurological	USEPA (P)
Antimony	7440-36-0	NA	NA	USEPA (I)
Arsenic	7440-38-2	1.5E-05	NA	USEPA (I)
Barium	7440-39-3	5.0E-04	Fetus	USEPA (I)
Beryllium	7440-41-7	2.0E-05	Immune, Respiratory	USEPA (I)
Cadmium (Diet)	7440-43-9-d	1.0E-05	Renal	USEPA (I)
Cadmium (Water)	7440-43-9	1.0E-05	Renal	USEPA (I)
Chromium, Trivalent	16065-83-1	NA	NA	USEPA (I)
Chromium, Hexavalent	18540-29-9	1.0E-04	Lungs	USEPA (I)
Cobalt	7440-48-4	6.0E-06	Respiratory Tract; Lung	USEPA (P)
Copper	7440-50-8	NA	NA	USEPA (H)
Iron	7439-89-6	NA	NA	USEPA (P)
Manganese (Diet)	7439-96-5-d	5.0E-05	Nervous	USEPA (I)
Manganese (Non-diet)	7439-96-5	USEPA (P)	Nervous	USEPA (S)
Mercury	7439-97-6	3.0E-04	Nervous	NA
Nickel	7440-02-0	9.0E-05	Resp.	USEPA (I)
Selenium	7782-49-2	2.0E-02	NA	USEPA (I)
Silver	7440-22-4	NA	NA	USEPA (I)
Thallium	7440-28-0	NA	NA	USEPA (X)
Vanadium	7440-62-2	1.0E-04	Resp.	USEPA (S)
Zinc	7440-66-6	NA	NA	USEPA (I)
Cyanide	57-12-5	8.0E-04	Thyroid	USEPA (I)
Fluoride	16984-48-8	1.3E-02	NA	USEPA (C)
2-Methylnaphthalene	91-57-6	NA	NA	USEPA (I)
4-Chloroaniline	106-47-8	NA	NA	USEPA (I)
Acenaphthene	83-32-9	NA	NA	USEPA (I)
Anthracene	120-12-7	NA	NA	USEPA (I)
Benzaldehyde	100-52-7	NA	NA	USEPA (I)
Benzo(A)Anthracene	56-55-3	NA	NA	NA
Benzo(A)Pyrene	50-32-8	2.0E-06	Developmental	USEPA (I)
Benzo(B)Fluoranthene	205-99-2	NA	NA	NA

Table 5-2
Non-Cancer Toxicity Data (Inhalation)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

COC	CAS No.	Chronic Inhalation RfC Value (a) mg/m ³	Primary Target Organ	Source (b)
Benzo(K)Fluoranthene	207-08-9	NA	NA	NA
Chrysene	218-01-9	NA	NA	NA
Dibenz(A,H)Anthracene	53-70-3	NA	NA	NA
Dibenzofuran	132-64-9	NA	NA	USEPA (X)
Fluoranthene	206-44-0	NA	NA	USEPA (I)
Fluorene	86-73-7	NA	NA	USEPA (I)
Indeno(1,2,3-C,D)Pyrene	193-39-5	NA	NA	NA
Isophorone	78-59-1	2.0E+00	NA	USEPA (I)
Naphthalene	91-20-3	3.0E-03	Nervous, Respiratory	USEPA (I)
Pyrene	129-00-0	NA	NA	USEPA (I)

Footnotes:

a/ mg/kg-day = milligrams per kilogram per day; NA = not available/not applicable

b/ Refer to text for citation

c/ OEHHA = California Office of Environmental Health Hazard Assessment -- Toxicity Criteria Database

DTSC = California Department of Toxic Substances Control -- toxicity criteria for TPH fractions

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C = Cal EPA

I = Integrated Risk Information System

H = HEAST

P = PPRTV

S = USEPA (2018) for user guide Section 5

X = PPRTV Appendix

Refer to text for references.

Table 6-1
Cancer Toxicity Data (Oral/Dermal)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

COC	CAS No.	Oral Cancer Slope Factor (a) (mg/kg-day)-1	Oral to Dermal Adjustment Factor	Oral to Dermal Adjustment Factor Source (b)	Adjusted Dermal Cancer Slope Factor (mg/kg-day)-1	Weight of Evidence/ Cancer Guideline Description (c)	Source (d)
Aluminum	7429-90-5	NA	1.00E+00	USEPA, 2018	NA		NA
Antimony	7440-36-0	NA	1.50E-01	USEPA, 2018	NA		NA
Arsenic	7440-38-2	1.5E+00	1.00E+00	USEPA, 2018	1.5E+00	A	USEPA (I)
Barium	7440-39-3	NA	7.00E-02	USEPA, 2018	NA		NA
Beryllium	7440-41-7	NA	7.00E-03	USEPA, 2018	NA		NA
Cadmium (Diet)	7440-43-9-d	NA	2.50E-02	USEPA, 2018	NA		NA
Cadmium (Water)	7440-43-9	NA	5.00E-02	USEPA, 2018	NA		NA
Chromium, Trivalent	16065-83-1	NA	1.30E-02	USEPA, 2018	NA		NA
Chromium, Hexavalent	18540-29-9	5.0E-01	2.50E-02	USEPA, 2018	1.3E-02	Known/likely (inhalation) cannot determine (oral)	USEPA (C)
Cobalt	7440-48-4	NA	1.00E+00	USEPA, 2018	NA		NA
Copper	7440-50-8	NA	1.00E+00	USEPA, 2018	NA		NA
Iron	7439-89-6	NA	1.00E+00	USEPA, 2018	NA		NA
Manganese (Diet)	7439-96-5-d	NA	1.00E+00	USEPA, 2018	NA		NA
Manganese (Non-diet)	7439-96-5	NA	4.00E-02	USEPA, 2018	NA		NA
Mercury	7439-97-6	NA	1.00E+00	USEPA, 2018	NA		NA
Nickel	7440-02-0	NA	4.00E-02	USEPA, 2018	NA		NA
Selenium	7782-49-2	NA	1.00E+00	USEPA, 2018	NA		NA
Silver	7440-22-4	NA	4.00E-02	USEPA, 2018	NA		NA
Thallium	7440-28-0	NA	1.00E+00	USEPA, 2018	NA		NA
Vanadium	7440-62-2	NA	2.60E-02	USEPA, 2018	NA		NA
Zinc	7440-66-6	NA	1.00E+00	USEPA, 2018	NA		NA
Cyanide	57-12-5	NA	1.00E+00	USEPA, 2018	NA		NA
Fluoride	16984-48-8	NA	1.00E+00	USEPA, 2018	NA		NA
2-Methylnaphthalene	91-57-6	NA	1.00E+00	USEPA, 2018	NA		NA
4-Chloroaniline	106-47-8	2.0E-01	1.00E+00	USEPA, 2018	2.0E-01	LI	USEPA (P)
Acenaphthene	83-32-9	NA	1.00E+00	USEPA, 2018	NA		NA
Anthracene	120-12-7	NA	1.00E+00	USEPA, 2018	NA		NA
Benzaldehyde	100-52-7	4.0E-03	1.00E+00	USEPA, 2018	4.0E-03	SU	USEPA (P)
Benzo(A)Anthracene	56-55-3	1.0E-01	1.00E+00	USEPA, 2018	1.0E-01	Carcinogenic to humans	USEPA (E)
Benzo(A)Pyrene	50-32-8	1.0E+00	1.00E+00	USEPA, 2018	1.0E+00	Carcinogenic to humans	USEPA (I)
Benzo(B)Fluoranthene	205-99-2	1.0E-01	1.00E+00	USEPA, 2018	1.0E-01	Carcinogenic to humans	USEPA (E)
Benzo(K)Fluoranthene	207-08-9	1.0E-02	1.00E+00	USEPA, 2018	1.0E-02	Carcinogenic to humans	USEPA (E)
Chrysene	218-01-9	1.0E-03	1.00E+00	USEPA, 2018	1.0E-03	Carcinogenic to humans	USEPA (E)
Dibenz(A,H)Anthracene	53-70-3	1.0E+00	1.00E+00	USEPA, 2018	1.0E+00	Carcinogenic to humans	USEPA (E)
Dibenzofuran	132-64-9	NA	1.00E+00	USEPA, 2018	NA		NA
Fluoranthene	206-44-0	NA	1.00E+00	USEPA, 2018	NA		NA
Fluorene	86-73-7	NA	1.00E+00	USEPA, 2018	NA		NA
Indeno(1,2,3-C,D)Pyrene	193-39-5	1.0E-01	1.00E+00	USEPA, 2018	1.0E-01	Carcinogenic to humans	USEPA (E)

Table 6-1
Cancer Toxicity Data (Oral/Dermal)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

COC	CAS No.	Oral Cancer Slope Factor (a) (mg/kg-day)-1	Oral to Dermal Adjustment Factor	Oral to Dermal Adjustment Factor Source (b)	Adjusted Dermal Cancer Slope Factor (mg/kg-day)-1	Weight of Evidence/ Cancer Guideline Description (c)	Source (d)
Isophorone	78-59-1	9.5E-04	1.00E+00	USEPA, 2018	9.5E-04	C	USEPA (l)
Naphthalene	91-20-3	NA	1.00E+00	USEPA, 2018	NA		NA
Pyrene	129-00-0	NA	1.00E+00	USEPA, 2018	NA		NA

Footnotes:

a/ mg/kg-day = milligrams per kilogram per day; NA = not available/not applicable

b/ Refer to text for citation

c/ Weight of evidence abbreviations:

USEPA classification

A - human carcinogen

B2 - probable human carcinogen; inadequate evidence that it can cause cancer in humans but at present it is far from conclusive

C - Probable human carcinogen; There is limited evidence that it can cause cancer in animals in the absence of human data, but at present it is not conclusive.□

D - Not Classifiable as to Human Carcinogenicity

IARC classification

Group 2A - Limited evidence in humans and sufficient evidence in animals

Group 2B - Limited evidence in humans and less than sufficient evidence in animals

Group 3 - Inadequate in humans and inadequate or limited in animals

d/ OEHHA = California Office of Environmental Health Hazard Assessment -- Toxicity Criteria Database

DTSC = California Department of Toxic Substances Control -- toxicity criteria for TPH fractions

CDWAL - California Drinking Water Action Level

USEPA = U.S. Environmental Protection Agency

HHRA note 3 = Refer to Text for citation

PA DEP = Pennsylvania Department of Environmental Protection

Reg 9 PRG = US EPA Region 9 Preliminary Remediation Goal

A = Agency for Toxic Substance and Disease Registry

C = Cal EPA

E = see USEPA (2018) for user guide Section 2.3.5

I = Integrated Risk Information System

H = HEAST

P = PPRTV

X = PPRTV Appendix

Refer to text for references.

Table 6-2
Cancer Toxicity Data (Inhalation)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

COC	CAS No.	Surrogate	Inhalation Unit Risk ($\mu\text{g}/\text{m}^3$)-1	Weight of Evidence/ Cancer Guideline Description (b)	Source (c)
Aluminum	7429-90-5		NA		NA
Antimony	7440-36-0		NA		NA
Arsenic	7440-38-2		4.3E-03	A	USEPA (I)
Barium	7440-39-3		NA		NA
Beryllium	7440-41-7		2.4E-03	Known/likely human carcinogen	USEPA (I)
Cadmium (Diet)	7440-43-9-d		1.8E-03	B1	USEPA (I)
Cadmium (Water)	7440-43-9		1.8E-03	B1	USEPA (I)
Chromium, Trivalent	16065-83-1		NA		NA
Chromium, Hexavalent	18540-29-9		8.4E-02	Known/likely (inhalation) cannot determine (oral)	USEPA (S)
Cobalt	7440-48-4		9.0E-03	LI	USEPA (P)
Copper	7440-50-8		NA		NA
Iron	7439-89-6		NA		NA
Manganese (Diet)	7439-96-5-d		NA		NA
Manganese (Non-diet)	7439-96-5		NA		NA
Mercury	7439-97-6		NA		NA
Nickel	7440-02-0		2.6E-04	A	USEPA (C)
Selenium	7782-49-2		NA		NA
Silver	7440-22-4		NA		NA
Thallium	7440-28-0		NA		NA
Vanadium	7440-62-2		NA		NA
Zinc	7440-66-6		NA		NA
Cyanide	57-12-5		NA		NA
Fluoride	16984-48-8		NA		NA
2-Methylnaphthalene	91-57-6		NA		NA
4-Chloroaniline	106-47-8		NA		NA
Acenaphthene	83-32-9		NA		NA
Anthracene	120-12-7		NA		NA
Benzaldehyde	100-52-7		NA		NA
Benzo(A)Anthracene	56-55-3		6.0E-05	Carcinogenic to humans	USEPA (E)
Benzo(A)Pyrene	50-32-8		6.0E-04	Carcinogenic to humans	USEPA (I)
Benzo(B)Fluoranthene	205-99-2		6.0E-05	Carcinogenic to humans	USEPA (E)
Benzo(K)Fluoranthene	207-08-9		6.0E-06	Carcinogenic to humans	USEPA (E)
Chrysene	218-01-9		6.0E-07	Carcinogenic to humans	USEPA (E)
Dibenz(A,H)Anthracene	53-70-3		6.0E-04	Carcinogenic to humans	USEPA (E)
Dibenzofuran	132-64-9		NA		NA
Fluoranthene	206-44-0		NA		NA

Table 6-2
Cancer Toxicity Data (Inhalation)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

COC	CAS No.	Surrogate	Inhalation Unit Risk ($\mu\text{g}/\text{m}^3$)-1	Weight of Evidence/ Cancer Guideline Description (b)	Source (c)
Fluorene	86-73-7		NA		NA
Indeno(1,2,3-C,D)Pyrene	193-39-5		6.0E-05	Carcinogenic to humans	USEPA (E)
Isophorone	78-59-1		NA		NA
Naphthalene	91-20-3		3.4E-05	Carcinogenic potential cannot be determined	USEPA (C)
Pyrene	129-00-0		NA		NA

Footnotes:

a/ $\mu\text{g}/\text{m}^3$ = micrograms per cubic meter. NA = not available/not applicable.

b/ Weight of evidence abbreviations:

USEPA classification

A - human carcinogen

B2 - probable human carcinogen; inadequate evidence that it can cause cancer in humans but at present it is far from conclusive

C - Probable human carcinogen; There is limited evidence that it can cause cancer in animals in the absence of human data, but at present it is not conclusive. □

D - Not Classifiable as to Human Carcinogenicity

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c/ OEHHA = California Office of Environmental Health Hazard Assessment -- Toxicity Criteria Database

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I = Integrated Risk Information System

H = HEAST

P = PPRTV

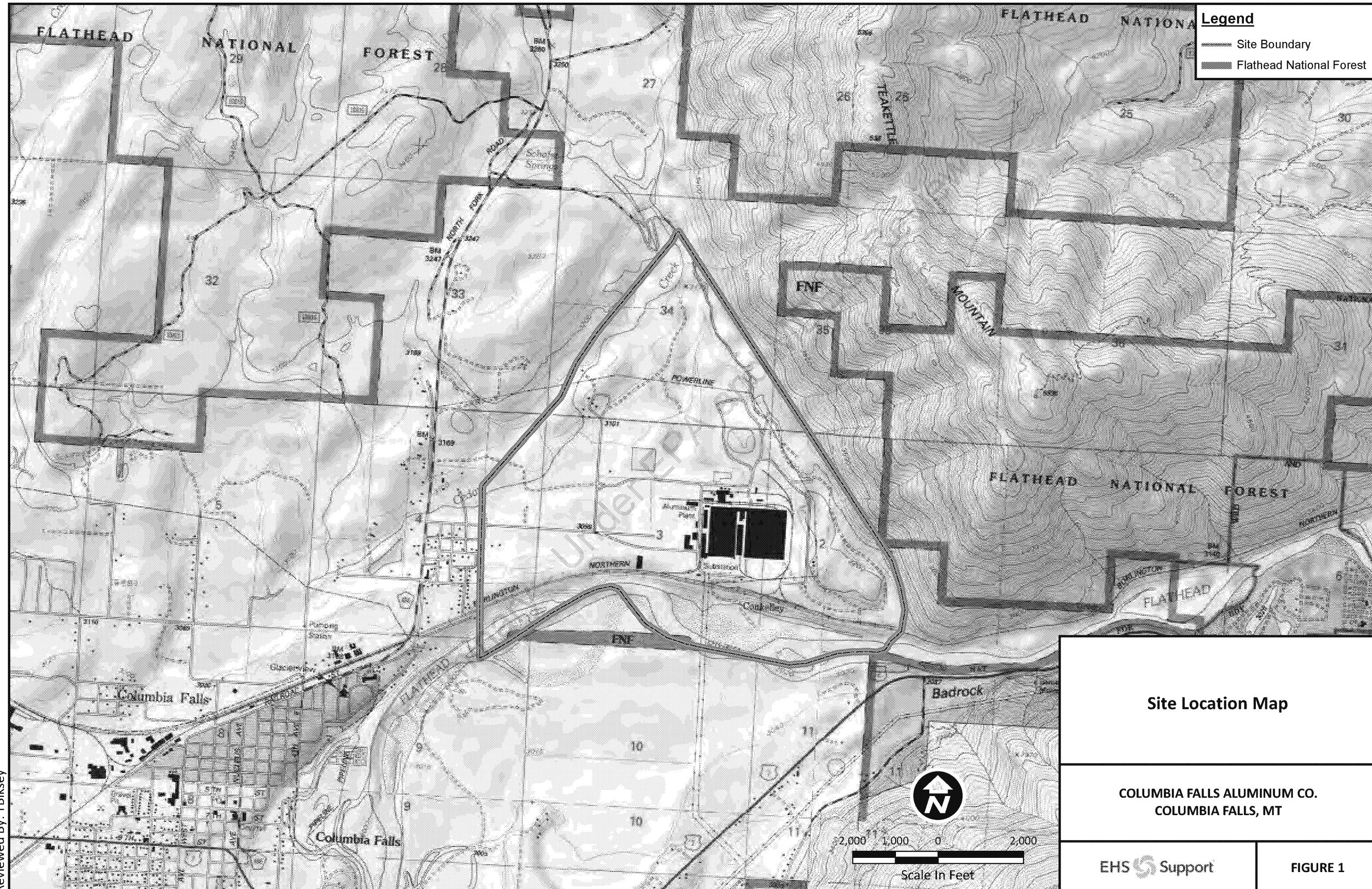
X = PPRTV Appendix

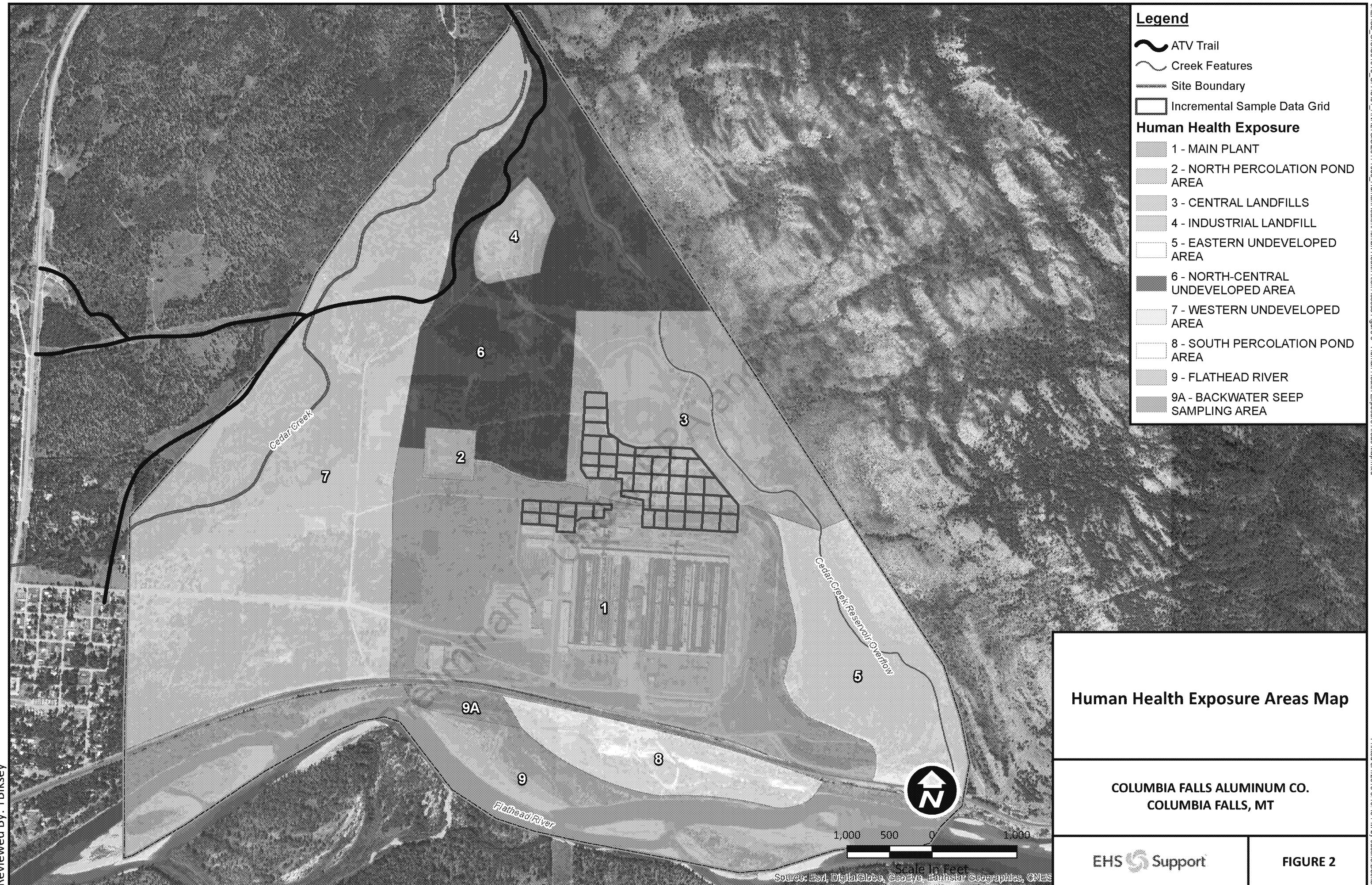
Refer to text for references.



Figures

Preliminary - Under EPA and MDEQ Review







Attachment A Datasets

Preliminary - Under EPA and MDEQ Review

Appendix A-1a	Main Plant Area Soil (0-0.5 ft-bgs)
Appendix A-1b	Main Plant Area Soil (0-12 ft-bgs)
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Appendix A-2d	North Percolation Pond Area (sediment)
Appendix A-3a	Central Landfill Area Soil (0-0.5 ft-bgs)
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Appendix A-12a	Main Plant ISS Area Soil (0-0.5 ft-bgs)
Appendix A-12b	Central Landfill ISS Area Soil (0-0.5 ft-bgs)
Appendix A-12c	Central Landfill ISS Area Soil (0-2 ft-bgs)

Appendix A-1a
Main Plant Area Soil (0-0.5 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-038	CFSB-040	CFSB-042	CFSB-044	CFSB-045	CFSB-046	CFSB-048	CFSB-050	CFSB-051	CFSB-054	CFSB-055	CFSB-057	CFSB-059	CFSB-059-DUP	CFSB-060	CFSB-062
Sample Lab IDs	460-114275-23 CFSB-038-SO-0-	460-114275-10 CFSB-040-SO-0-	460-114275-7 CFSB-042-SO-0-	460-114141-46 CFSB-044-SO-0-	460-114275-27 CFSB-045-SO-0-	460-114141-44 CFSB-046-SO-0-	460-114141-49 CFSB-048-SO-0-	460-114275-24 CFSB-050-SO-0-	460-114275-16 CFSB-051-SO-0-	460-114793-20 CFSB-054-SO-0-	460-114793-19 CFSB-055-SO-0-	460-114793-27 CFSB-057-SO-0-	460-114793-30 CFSB-059-SO-0-	460-114793-29 CFSB-060-SO-0-	460-114793-8 CFSB-062-SO-0-	
Sample Name	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sample Depth	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft
Chemical	5/21/2016	5/20/2016	5/20/2016	5/20/2016	5/21/2016	5/20/2016	5/20/2016	5/21/2016	5/21/2016	5/28/2016	5/28/2016	5/28/2016	5/28/2016	5/28/2016	5/27/2016	6/2/2016

GENERAL CHEMISTRY | ANIONS (mg/kg)

Fluoride	87.3	203 J-	50.7 J-	330 J-	199	31.7 J-	109 J-	126	77 J-	44 J	147 J-	75.7 J-	51.2 J-	52.1 J-	16.4 J	25.9 J
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Footnotes:

- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1a Main Plant Area Soil (0-0.5 ft-bgs) Data Used in Human Health Risk Assessment Columbia Falls Aluminum Facility Columbia Falls, Montana																
Sample Location ID	CFSB-064	CFSB-065	CFSB-066	CFSB-069	CFSB-071	CFSB-073	CFSB-074	CFSB-075	CFSB-079	CFSB-080	CFSB-082	CFSB-084	CFSB-086	CFSB-087	CFSB-088	CFSB-092
Sample Lab IDs	460-115008-7 CFSB-064-SO-0-	460-114828-34 CFSB-065-SO-0-	460-114793-12 CFSB-066-SO-0-	460-114793-14 CFSB-069-SO-0-	460-114793-4 CFSB-071-SO-0-	320-19320-22, 460-114828-7 CFSB-073-SO-0-	320-19320-31, 460-114828-17 CFSB-074-SO-0-	320-19320-23, 460-114828-8 CFSB-075-SO-0-	320-19320-27, 460-114828-10 CFSB-079-SO-0-	320-19320-26, 460-114828-13 CFSB-080-SO-0-	320-19320-13, 460-114828-11 CFSB-082-SO-0-	320-19320-10, 460-114793-3 CFSB-084-SO-0-	320-19320-7, 460- 114529-25 CFSB-086-SO-0-	320-19320-4, 460- 114529-22 CFSB-087-SO-0-	320-19320-1, 460- 114529-19 CFSB-088-SO-0-	320-19320-4, 460- 114529-19 CFSB-092-SO-0-
Sample Name	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sample Depth	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft
Chemical	6/3/2016	6/2/2016	5/27/2016	5/27/2016	5/27/2016	6/1/2016	6/1/2016	6/1/2016	6/1/2016	6/1/2016	6/1/2016	6/1/2016	5/27/2016	5/26/2016	5/26/2016	5/26/2016
GENERAL CHEMISTRY ANIONS (mg/kg)																
Fluoride	33.3 J	46.8 J	571 J	36.3 J	47.3 J	28.2 J	143 J	43 J	55.4 J	35.7 J	30.4 J	59.6 J	21.1 J+	34.9 J+	23.5 J+	14.1 J

Footnotes:

-- = not applicable

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+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1a
Main Plant Area Soil (0-0.5 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-094	CFSB-095	CFSB-097	CFSB-098	CFSB-099	CFSB-100	CFSB-121	CFSB-121-DUP	CFSB-128	CFSB-129	CFMW-025A	CFMW-026	CFMW-032A	CFMW-032A	CFMW-053A	CFMW-053A
Sample Lab IDs	460-114456-42 CFSB-094-SO-0-	460-114456-37 CFSB-095-SO-0-	460-114456-25 CFSB-097-SO-0-	460-114456-27 CFSB-098-SO-0-	460-114456-23 CFSB-099-SO-0-	460-114456-26 CFSB-100-SO-0-	460-114141-20 CFSB-121-SO-0-	460-114141-23 CFSB-DUP1-SO	460-114456-39 CFSB-128-SO-0-	460-114456-44 CFSB-129-SO-0-	460-117124-1 CFMW-025a-SO-0	460-115528-27 CFMW-026-SO-0	460-118466-1 CFMW-032a-SO-0	460-118466-2 CFMW-032a-SO-0	460-118952-2 CFMW-053a-SO-0	460-118952-3 CFMW-053a-SO-0
Sample Name	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5Pb	0.5	0.5Pb
Sample Depth	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft						
Chemical	5/24/2016	5/24/2016	5/24/2016	5/24/2016	5/24/2016	5/24/2016	5/18/2016	5/18/2016	5/24/2016	5/24/2016	7/13/2016	6/14/2016	8/8/2016	8/8/2016	8/17/2016	8/17/2016

GENERAL CHEMISTRY|ANIONS (mg/kg)

Fluoride	86.9 J-	19.5 J-	80.1 J-	93.3 J-	41.7 J+	39.2 J+	13.5 J-	9.05 J-	46.7 J-	214 J-	16.7 J	4.25 J	78.1 J	--	8.82	--
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1a
Main Plant Area Soil (0-0.5 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-028A	CFMW-028A	CFMW-033	CFMW-033	CFMW-034	CFMW-035	CFMW-035-DUP	CFMW-037	CFMW-038 320-19945-1, 460-116119-6	CFMW-038 460-116119-9	CFMW-040 320-19945-4, 460-116283-1	CFMW-040 460-116283-6	CFMW-042 460-115648-15	CFMW-042 460-115648-19	CFMW-043 460-115648-3	CFMW-043 460-115648-10
Sample Lab IDs	460-116402-2 CFMW-028a-SO-0	460-116402-9 CFMW-028a-SO-0	460-116402-16 CFMW-033-SO-0	460-116402-19 CFMW-033-SO-0	460-114793-41 CFMW-034-SO-0	460-114828-22 CFMW-035-SO-0	460-114828-23 CFMW-037-SO-0	460-116119-2 CFMW-038-SO-0	460-116119-6 CFMW-038-SO-0	460-116119-9 CFMW-038-SO-0	460-116283-1 CFMW-040-SO-0	460-116283-6 CFMW-040-SO-0	460-116283-6 CFMW-042-SO-0	460-116283-6 CFMW-042-SO-0	460-116283-6 CFMW-043-SO-0	460-116283-6 CFMW-043-SO-0
Sample Name	0.5	0.5Pb	0.5	0.5Pb	0.5	0.5	0.5	0.5	0.5	0.5 Pb	0.5	0.5Pb	0.5	0.5-Pb	0.5	0.5-Pb
Sample Depth	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft						
Chemical	6/30/2016	6/30/2016	7/1/2016	7/1/2016	5/31/2016	6/1/2016	6/1/2016	6/24/2016	6/25/2016	6/25/2016	6/28/2016	6/28/2016	6/16/2016	6/16/2016	6/15/2016	6/15/2016

GENERAL CHEMISTRY | ANIONS (mg/kg)

Fluoride	6.47 J+	--	8.12 J+	--	42.8 J	98.3 J	123 J	192 J	22.3 J+	--	27.6 J+	--	47.5 J-	--	84.9 J-	--
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Footnotes:

-- = not applicable

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+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1a
Main Plant Area Soil (0-0.5 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-044A	CFMW-044A	CFMW-045A	CFMW-047	CFMW-047	CFMW-049	CFMW-049A	CFMW-050	CFMW-050	CFMW-054
Sample Lab IDs	460-117381-5 CFMW-044a-SO-0	460-117506-7 CFMW-044a-SO-0	460-118613-2 CFMW-045a-SO-0	460-115886-20 CFMW-047-SO-0	460-116014-1 CFMW-047-SO-0	460-119134-1 CFMW-049-SO-0	460-119134-7 CFMW-049a-SO-0	460-116014-7 CFMW-050-SO-0	460-116014-13 CFMW-050-SO-0	460-115886-3 CFMW-054-SO-
Sample Name	0.5	0.5Pb	0.5	0.5	0.5-Pb	0.5	0.5 Pb	0.5	0.5-Pb	0-0.5
Sample Depth	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft
Chemical	7/20/2016	7/20/2016	8/12/2016	6/21/2016	6/21/2016	8/20/2016	8/20/2016	6/22/2016	6/22/2016	6/20/2016
GENERAL CHEMISTRY ANIONS (mg/kg)										
Fluoride	59.8 J+	--	74.8 J	22.2 J	--	11.4 J+	--	21.2 J+	--	231 J

Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1b
Main Plant Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-010	CFSB-010	CFSB-012	CFSB-012	CFSB-038	CFSB-038	CFSB-038	CFSB-040	CFSB-040	CFSB-040	CFSB-042	CFSB-042	CFSB-042	CFSB-044	CFSB-044	CFSB-044
Sample Lab IDs	460-114275-19 CFSB-010-SO-0.5-	460-114275-20 CFSB-010-SO-10-	460-114793-22 CFSB-012-SO-0.5-	460-114793-23 CFSB-012-SO-10-	460-114275-23 CFSB-038-SO-0-	460-114275-21 CFSB-038-SO-0.5-	460-114275-22 CFSB-038-SO-10-	460-114275-10 CFSB-040-SO-0-	460-114275-11 CFSB-040-SO-0.5-	460-114275-12 CFSB-040-SO-10-	460-114275-7 CFSB-042-SO-0-	460-114275-8 CFSB-042-SO-0.5-	460-114275-9 CFSB-042-SO-10-	460-114141-46 CFSB-044-SO-0-	460-114141-47 CFSB-044-SO-0.5-	460-114141-48 CFSB-044-SO-10-
Sample Name	2	12	2	12	0.5	2	12	0.5	2	12	0.5	2	12	0.5	2	12
Sample Depth	0.5-2 ft	10-12 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft
Chemical	5/21/2016	5/21/2016	5/28/2016	5/28/2016	5/21/2016	5/21/2016	5/21/2016	5/20/2016	5/20/2016	5/20/2016	5/20/2016	5/20/2016	5/20/2016	5/20/2016	5/20/2016	5/20/2016

GENERAL CHEMISTRY|ANIONS (mg/kg)

Fluoride	37.9 J-	16.1 J-	42.4 J	7.44 J	87.3	54.4 J-	8.5	203 J-	66.8 J-	37.1 J-	50.7 J-	33.1 J-	12.8 J-	330 J-	310 J-	9.64 J-
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1b
Main Plant Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-045	CFSB-045	CFSB-045	CFSB-046	CFSB-046	CFSB-046	CFSB-048	CFSB-048	CFSB-048	CFSB-049	CFSB-049	CFSB-050	CFSB-050	CFSB-050	CFSB-051	CFSB-051
Sample Lab IDs	460-114275-27 CFSB-045-SO-0-	460-114275-28 CFSB-045-SO-0.5-	460-114275-29 CFSB-045-SO-10-	460-114141-44 CFSB-046-SO-0-	460-114141-45 CFSB-046-SO-0.5-	460-114275-15 CFSB-046-SO-10-	460-114141-49 CFSB-048-SO-0-	460-114141-50 CFSB-048-SO-0.5-	460-114141-51 CFSB-048-SO-10-	460-114793-34 CFSB-049-SO-0.5-	460-114793-32 CFSB-049-SO-10-	460-114275-24 CFSB-050-SO-0-	460-114275-25 CFSB-050-SO-10-	460-114275-26 CFSB-051-SO-0-	460-114275-16 CFSB-051-SO-0.5-	
Sample Name	0.5	2	12	0.5 ft	0.5 ft	2.0	12	0.5	2.0	12	2	12	0.5	2	12	2
Sample Depth	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft
Chemical	5/21/2016	5/21/2016	5/21/2016	5/20/2016	5/20/2016	5/20/2016	5/20/2016	5/20/2016	5/20/2016	5/28/2016	5/28/2016	5/21/2016	5/21/2016	5/21/2016	5/21/2016	5/21/2016

GENERAL CHEMISTRY|ANIONS (mg/kg)

Fluoride	199	140	164	31.7 J-	13.7 J-	10.7 J-	109 J-	57.7 J-	18.6 J-	23.3 J	4.48 J	126	165	23.4	77 J-	73 J-
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1b
Main Plant Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-051	CFSB-052	CFSB-052	CFSB-053	CFSB-053	CFSB-054	CFSB-054	CFSB-054	CFSB-055	CFSB-055	CFSB-055	CFSB-055	CFSB-057	CFSB-057	CFSB-057	CFSB-059	CFSB-059-DUP
Sample Lab IDs	460-114275-18 CFSB-051-SO-10- 12	460-114275-13 CFSB-052-SO-0.5- 2	460-114275-14 CFSB-052-SO-10- 12	460-114793-56 CFSB-053-SO-0.5- 2	460-114793-58 CFSB-053-SO-10- 12	460-114793-20 CFSB-054-SO-0- 0.5	460-114793-25 CFSB-054-SO-0.5- 2	460-114793-24 CFSB-055-SO-0- 12	460-114793-19 CFSB-055-SO-0.5- 0.5	460-114793-21 CFSB-055-SO-10- 2	460-114793-26 CFSB-057-SO-0- 12	460-114793-27 CFSB-057-SO-0.5- 0.5	460-114793-35 CFSB-057-SO-10- 2	460-114793-31 CFSB-059-SO-0- 12	460-114793-30 CFSB-059-SO-0- 0.5	460-114793-29 CFSB-DUP8-SO 0-0.5 ft 5/28/2016	
Sample Name																	
Sample Depth	10-12 ft	0.5-2 ft	10-12 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0-0.5 ft	
Chemical	5/21/2016	5/20/2016	5/20/2016	5/31/2016	5/31/2016	5/28/2016	5/28/2016	5/28/2016	5/28/2016	5/28/2016	5/28/2016	5/28/2016	5/28/2016	5/28/2016	5/28/2016	5/28/2016	

GENERAL CHEMISTRY|ANIONS (mg/kg)

Fluoride	81.1 J-	1.55 J-	4.16 J-	25.8 J	2 J+	44 J	58.1 J-	13.1 J	147 J	129 J	95.4 J	75.7 J-	76.2 J	13.5 J	51.2 J-	52.1 J-
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1b
Main Plant Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-059	CFSB-059	CFSB-060	CFSB-060	CFSB-060	CFSB-062	CFSB-062	CFSB-062	CFSB-064	CFSB-064	CFSB-064	CFSB-064	CFSB-065	CFSB-065	CFSB-065	CFSB-066	CFSB-066
Sample Lab IDs	460-114793-33	460-114793-28	460-114793-8	460-114793-2	460-114793-10	460-114828-40	460-114828-39	460-114828-41	460-115008-7	460-115008-8	460-115008-9	460-114828-34	460-114828-36	460-114828-32	460-114793-12	460-114793-1	
Sample Name	CFSB-059-SO-0.5-	CFSB-059-SO-10-	CFSB-060-SO-0-	CFSB-060-SO-0.5-	CFSB-060-SO-10-	CFSB-062-SO-0-	CFSB-062-SO-0.5-	CFSB-062-SO-0-	CFSB-064-SO-0-	CFSB-064-SO-0.5-	CFSB-064-SO-0-	CFSB-064-SO-10-	CFSB-065-SO-0-	CFSB-065-SO-0.5-	CFSB-065-SO-10-	CFSB-066-SO-0-	CFSB-066-SO-0.5-
Sample Depth	2	12	0.5	2	12	0.5	2	12	0.5	2	12	0.5	2	12	0.5	2	2
Chemical	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	0.5-2 ft
	5/28/2016	5/28/2016	5/27/2016	5/27/2016	5/27/2016	6/2/2016	6/2/2016	6/2/2016	6/3/2016	6/3/2016	6/3/2016	6/2/2016	6/2/2016	6/2/2016	6/2/2016	5/27/2016	5/27/2016

GENERAL CHEMISTRY|ANIONS (mg/kg)

Fluoride	42.5 J-	21.6 J-	16.4 J	11.3 J	6.74 J	25.9 J	27.5 J	17.3 J	33.3 J	71.2 J	0.19 UJ	46.8 J	57.1 J	9.92 J	571 J	367 J
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1b
Main Plant Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-066	CFSB-068	CFSB-068	CFSB-069	CFSB-069	CFSB-069	CFSB-069	CFSB-071	CFSB-071	CFSB-071-DUP	CFSB-073	CFSB-073	CFSB-073	CFSB-074	CFSB-074	CFSB-074
Sample Lab IDs	460-114793-16	460-114793-18	460-114793-11	460-114793-14	460-114793-15	460-114793-17	460-114793-4	460-114793-9	460-114793-13	460-114793-7	320-19320-22,	320-19320-17,	320-19320-18,	320-19320-31,	320-19320-16,	320-19320-30,
Sample Name	CFSB-066-SO-10-	CFSB-068-SO-0.5-	CFSB-068-SO-10-	CFSB-069-SO-0-	CFSB-069-SO-0.5-	CFSB-069-SO-10-	CFSB-071-SO-0-	CFSB-071-SO-0.5-	CFSB-071-SO-10-	CFSB-073-SO-0-	460-114828-7	460-114828-2	460-114828-3	460-114828-17	460-114828-1	460-114828-16
Sample Depth	12	2	12	0.5	0.5	2	12	0.5	2	0.5	2	2	12	0.5	2	12
Chemical	10-12 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	6/1/2016	6/1/2016	6/1/2016	6/1/2016	6/1/2016	6/1/2016

GENERAL CHEMISTRY|ANIONS (mg/kg)

Fluoride	25.2 J	19 J	28.1 J+	36.3 J	39.8 J	6.42 J	47.3 J	54 J	3.16 J	4.28 J	28.2 J	24.3 J	10.3 J	143 J	8.98 J	28.3 J
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1b Main Plant Area Soil (0-12 ft-bgs) Data Used in Human Health Risk Assessment Columbia Falls Aluminum Facility Columbia Falls, Montana																
Sample Location ID	CFSB-075 320-19320-23, 460-114828-8	CFSB-075 320-19320-19, 460-114828-4	CFSB-075 320-19320-21, 460-114828-6	CFSB-079 320-19320-25, 460-114828-10	CFSB-079 320-19320-24, 460-114828-9	CFSB-079 320-19320-20, 460-114828-5	CFSB-080 320-19320-27, 460-114828-13	CFSB-080 320-19320-28, 460-114828-14	CFSB-080 320-19320-33, 460-114828-12	CFSB-082 320-19320-26, 460-114828-11	CFSB-082 320-19320-32, 460-114828-18	CFSB-082 320-19320-29, 460-114828-15	CFSB-084 320-19320-13, 460-114793-3	CFSB-084 320-19320-14, 460-114793-6	CFSB-084 320-19320-15, 460-114529-28	CFSB-086 320-19320-10, 460-114529-28
Sample Lab IDs	CFSB-075-SO-0- 0.5	CFSB-075-SO-0-5- 2	CFSB-075-SO-10- 12	CFSB-079-SO-0- 0.5	CFSB-079-SO-0-5- 2	CFSB-079-SO-10- 12	CFSB-080-SO-0- 0.5	CFSB-080-SO-10- 2	CFSB-080-SO-10- 12	CFSB-082-SO-0- 0.5	CFSB-082-SO-10- 2	CFSB-084-SO-0- 0.5	CFSB-084-SO-10- 2	CFSB-084-SO-0-5- 12	CFSB-086-SO-0- 0.5	
Sample Name																
Sample Depth	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft
Chemical	6/1/2016	6/1/2016	6/1/2016	6/1/2016	6/1/2016	6/1/2016	6/1/2016	6/1/2016	6/1/2016	6/1/2016	6/1/2016	6/1/2016	5/27/2016	5/27/2016	5/27/2016	5/26/2016
GENERAL CHEMISTRY ANIONS (mg/kg)																
Fluoride	43 J	33.7 J	26.8 J	55.4 J	20.3 J	21.5 J	35.7 J	8.79 J	10.2 J	30.4 J	18.2 J	5.35 J	59.6 J	24.1 J	7.15 J	21.1 J+

Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1b Main Plant Area Soil (0-12 ft-bgs) Data Used in Human Health Risk Assessment Columbia Falls Aluminum Facility Columbia Falls, Montana																	
Sample Location ID	CFSB-086 320-19320-11, 460-114529-29	CFSB-086 320-19320-12, 460-114529-30	CFSB-087 320-19320-7, 460- 114529-25	CFSB-087 320-19320-8, 460- 114529-26	CFSB-087 320-19320-9, 460- 114529-27	CFSB-088 320-19320-4, 460- 114529-22	CFSB-088 320-19320-5, 460- 114529-23	CFSB-088 320-19320-6, 460- 114529-24	CFSB-092 320-19320-1, 460- 114529-19	CFSB-092 320-19320-2, 460- 114529-20	CFSB-092 320-19320-3, 460- 114529-21	CFSB-094 460-114456-42	CFSB-094 460-114456-43	CFSB-094 460-114456-41	CFSB-094 460-114456-37	CFSB-095 CFSB-095-SO-0.5-	CFSB-095 460-114456-38
Sample Lab IDs	CFSB-086-SO-0.5- 2 0.5-2 ft 5/26/2016	CFSB-086-SO-10- 12 10-12 ft 5/26/2016	CFSB-087-SO-0- 0.5 0-0.5 ft 5/26/2016	CFSB-087-SO-0.5- 2 0.5-2 ft 5/26/2016	CFSB-088-SO-0- 0.5 0-0.5 ft 5/26/2016	CFSB-088-SO-10- 2 0.5-2 ft 5/26/2016	CFSB-088-SO-0- 0.5 0-0.5 ft 5/26/2016	CFSB-092-SO-0- 2 0.5-2 ft 5/26/2016	CFSB-092-SO-0.5- 2 0.5-2 ft 5/26/2016	CFSB-092-SO-10- 12 0-0.5 ft 5/26/2016	CFSB-094-SO-0- 0.5 0-0.5 ft 5/26/2016	CFSB-094-SO-10- 2 0.5-2 ft 5/26/2016	CFSB-094-SO-0- 12 0-0.5 ft 5/26/2016	CFSB-095-SO-0- 0.5 0-0.5 ft 5/26/2016	CFSB-095-SO-0.5- 2.0 0.5-2 ft 5/26/2016	CFSB-095-SO-0.5- 2.0 0.5-2 ft 5/26/2016	CFSB-095-SO-0.5- 2.0 0.5-2 ft 5/26/2016
Sample Name																	
Sample Depth																	
Chemical																	
GENERAL CHEMISTRY ANIONS (mg/kg)																	
Fluoride	12.9 J+	18.6 J+	34.9 J+	29.3 J+	17.2 J+	23.5 J+	25.8 J+	5.88 J+	14.1 J	29.9 J	2.35 J+	86.9 J-	63.2 J-	1.49 J-	19.5 J-	16.9 J-	

Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1b
Main Plant Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-095	CFSB-097	CFSB-097	CFSB-097	CFSB-098	CFSB-098	CFSB-098	CFSB-099	CFSB-099	CFSB-099	CFSB-100	CFSB-100	CFSB-100	CFSB-121	CFSB-121-DUP	CFSB-121
Sample Lab IDs	460-114456-36 CFSB-095-SO-10- 12	460-114456-25 CFSB-097-SO-0- 0.5	460-114456-34 CFSB-097-SO-0.5- 2	460-114456-31 CFSB-097-SO-10- 0.5	460-114456-27 CFSB-098-SO-0- 0.5	460-114456-32 CFSB-098-SO-0.5- 2	460-114456-35 CFSB-098-SO-10- 12	460-114456-23 CFSB-099-SO-0- 0.5	460-114456-28 CFSB-099-SO-0.5- 2	460-114456-30 CFSB-099-SO-10- 12	460-114456-26 CFSB-100-SO-0- 0.5	460-114456-33 CFSB-100-SO-0.5- 2	460-114456-29 CFSB-100-SO-10- 12	460-114141-20 CFSB-121-SO-0- 0.5	460-114141-23 CFSB-DUP1-SO 2.0	460-114141-21 CFSB-121-SO-0.5- 2.0
Sample Name																
Sample Depth	10-12 ft 5/24/2016	0-0.5 ft 5/24/2016	0.5-2 ft 5/24/2016	10-12 ft 5/24/2016	0-0.5 ft 5/24/2016	0.5-2 ft 5/24/2016	10-12 ft 5/24/2016	0-0.5 ft 5/24/2016	0.5-2 ft 5/24/2016	10-12 ft 5/24/2016	0-0.5 ft 5/24/2016	0.5-2 ft 5/24/2016	10-12 ft 5/24/2016	0-0.5 ft 5/24/2016	0.5-2 ft 5/18/2016	0.5-2 ft 5/18/2016
Chemical																

GENERAL CHEMISTRY | ANIONS (mg/kg)

Fluoride	10.4 J-	80.1 J-	47.6 J-	1.29 J-	93.3 J-	79.9 J-	141 J-	41.7 J+	3.18 J+	2.87 J+	39.2 J+	90.9 J-	16.6 J+	13.5 J-	9.05 J-	10.1 J-
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1b
Main Plant Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-121	CFSB-128	CFSB-128	CFSB-128	CFSB-129	CFSB-129	CFSB-129	CFSB-130	CFSB-130	CFSB-131	CFSB-131	CFMW-025A	CFMW-025A	CFMW-025A	CFMW-026	CFMW-026
Sample Lab IDs	460-114141-22 CFSB-121-SO-10-12	460-114456-39 CFSB-128-SO-0-0.5	460-114456-40 CFSB-128-SO-0.5-2.0	460-114456-47 CFSB-128-SO-10-12	460-114456-44 CFSB-129-SO-0-0.5	460-114456-46 CFSB-129-SO-0.5-2.0	460-114456-45 CFSB-129-SO-10-12	460-115731-5 CFSB-130-SO-0.5-2	460-115731-6 CFSB-130-SO-10-12	460-115731-1 CFSB-131-SO-0.5-2	460-115731-2 CFSB-131-SO-10-12	460-117124-1 CFMW-025a-SO-0.5	460-117124-3 CFMW-025a-SO-0.5-2	460-117124-4 CFMW-026-SO-0-10-12	460-115528-27 CFMW-026-SO-0-0.5	460-115528-26 CFMW-026-SO-0.5-2
Sample Name																
Sample Depth	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0.5-2 ft	10-12 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft
Chemical	5/18/2016	5/24/2016	5/24/2016	5/24/2016	5/24/2016	5/24/2016	5/24/2016	6/17/2016	6/17/2016	6/17/2016	6/17/2016	7/13/2016	7/13/2016	7/13/2016	6/14/2016	6/14/2016

GENERAL CHEMISTRY | ANIONS (mg/kg)

Fluoride	1.38 J-	46.7 J-	63.4 J-	10.6 J-	214 J-	203 J-	123 J-	2.46	232 J-	3.82	86.7 J-	16.7 J	7.99 J	2.06 J	4.25 J	4.09 J
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1b
Main Plant Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-026-DUP	CFMW-026	CFMW-028A	CFMW-028A	CFMW-028A	CFMW-028A	CFMW-028A	CFMW-028A-DUP	CFMW-032A	CFMW-032A	CFMW-032A	CFMW-032A	CFMW-032A-DUP	CFMW-033	CFMW-033	CFMW-033
Sample Lab IDs	460-115528-25	460-115528-28	460-116402-2	460-116402-9	460-116402-3	460-116402-10	460-116402-4	460-116402-6	460-118466-1	460-118466-2	460-118466-3	460-118466-4	460-118466-6	460-116402-16	460-116402-19	460-116402-17
Sample Name	CFMW-DUP15-SO	CFMW-026-SO-10	CFMW-028a-SO-0	CFMW-028a-SO-0	CFMW-028a-SO-0	CFMW-028a-SO-0	CFMW-028a-SO-0	CFMW-032a-SO-0	CFMW-032a-SO-0	CFMW-032a-SO-0	CFMW-032a-SO-0	CFMW-032a-SO-0	CFMW-032a-SO-0	CFMW-033-SO-0	CFMW-033-SO-0	CFMW-033-SO-0
Sample Depth	0.5-2 ft	10-12 ft	0-0.5 ft	0-0.5 ft	0.5-2 ft	4.5-6 ft	10-12 ft	10-12 ft	0-0.5 ft	0-0.5 ft	0.5-2 ft	10-12 ft	10-12 ft	0-0.5 ft	0-0.5 ft	0.5-2 ft
Chemical	6/14/2016	6/14/2016	6/30/2016	6/30/2016	6/30/2016	6/30/2016	6/30/2016	8/8/2016	8/8/2016	8/8/2016	8/8/2016	8/8/2016	8/8/2016	7/1/2016	7/1/2016	7/1/2016

GENERAL CHEMISTRY|ANIONS (mg/kg)

Fluoride	84.1 J	51.7 J	6.47 J+	--	20.1 J+	293 J+	13.8 J+	14.9 J+	78.1 J	--	61.6 J	1.57 J	1.59 J	8.12 J+	--	36.8 J+
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1b
Main Plant Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-033	CFMW-034	CFMW-034	CFMW-034-DUP	CFMW-034	CFMW-035	CFMW-035-DUP	CFMW-035	CFMW-035	CFMW-037	CFMW-037	CFMW-037	CFMW-038	CFMW-038	CFMW-038
Sample Lab IDs	460-116402-18 CFMW-033-SO-10	460-114793-41 CFMW-034-SO-0-	460-114793-42 CFMW-034-SO-	460-114793-44 CFMW-034-SO-10	460-114793-43 CFMW-034-SO-10	460-114828-22 CFMW-035-SO-0-	460-114828-23 CFMW-035-SO-10	460-114828-20 CFMW-035-SO-10	460-114828-21 CFMW-037-SO-10	460-116119-2 CFMW-037-SO-0-	460-116119-3 CFMW-037-SO-10	460-116119-4 CFMW-038-SO-0-	320-19945-1, 460-116119-6 CFMW-038-SO-0-	460-116119-9 CFMW-038-SO-0-	320-19945-2, 460-116119-7 CFMW-038-SO-12
Sample Name	12	0.5	0.5-2	0.5-2 ft	10-12 ft	0-0.5 ft	0-0.5 ft	0.5-2	12	0.5	0.5-2	12	0.5	0.5-2	12
Sample Depth	10-12 ft	0-0.5 ft	0.5-2 ft	0.5-2 ft	5/31/2016	5/31/2016	6/1/2016	6/1/2016	6/1/2016	6/1/2016	6/24/2016	6/24/2016	6/24/2016	6/25/2016	6/25/2016
Chemical	7/1/2016	5/31/2016	5/31/2016	5/31/2016											

GENERAL CHEMISTRY|ANIONS (mg/kg)

Fluoride	11.3 J+	42.8 J	42.4 J	21.6 J-	7.39 J-	98.3 J	123 J	11.1 J	8.7 J	192 J	39.2 J+	12.3 J+	22.3 J+	--	25.8 J+	21.5 J+
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1b
Main Plant Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-040 320-19945-4, 460-116283-1	CFMW-040 460-116283-6	CFMW-040 320-19945-5, 460-116283-2	CFMW-040 320-19945-6, 460-116283-3	CFMW-042 460-115648-15	CFMW-042 460-115648-19	CFMW-042 460-115648-16	CFMW-042-DUP 460-115648-18	CFMW-042 460-115648-17	CFMW-043 460-115648-3	CFMW-043 460-115648-10	CFMW-043 460-115648-4	CFMW-043 460-115648-5	CFMW-044A 460-117381-5	CFMW-044A 460-117506-7	CFMW-044A 460-117381-6
Sample Lab IDs	CFMW-040-SO-0- 0.5	CFMW-040-SO-0- 0.5Pb	CFMW-040-SO-0- 0.5-2	CFMW-040-SO-0- 12	CFMW-042-SO-0- 0.5	CFMW-042-SO-0- 0.5-Pb	CFMW-042-SO-0- 0.5-2	CFMW-DUP16-SO 6/16/2016	CFMW-042-SO-0- 12	CFMW-043-SO-0- 0.5	CFMW-043-SO-0- 0.5-Pb	CFMW-043-SO-0- 0.5-2	CFMW-043-SO-0- 12	CFMW-044a-SO-0- 0.5	CFMW-044a-SO-0- 0.5Pb	CFMW-044a-SO-0- 0.5-2
Sample Name																
Sample Depth	0-0.5 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0-0.5 ft	0.5-2 ft	
Chemical	6/28/2016	6/28/2016	6/28/2016	6/28/2016	6/16/2016	6/16/2016	6/16/2016	6/16/2016	6/16/2016	6/15/2016	6/15/2016	6/15/2016	6/15/2016	7/20/2016	7/20/2016	7/20/2016

GENERAL CHEMISTRY|ANIONS (mg/kg)

Fluoride	27.6 J+	--	22.1 J+	14 J+	47.5 J-	--	22.9 J	41.5 J	5.29 J	84.9 J-	--	86.2 J-	4.91 J-	59.8 J+	--	34 J+
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1b
Main Plant Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-044A	CFMW-045A	CFMW-045A	CFMW-045A	CFMW-047	CFMW-047	CFMW-047	CFMW-047	CFMW-049	CFMW-049A	CFMW-049A	CFMW-049A	CFMW-050	CFMW-050	CFMW-050-DUP
Sample Lab IDs	460-117381-7 CFMW-044a-SO-0	460-118613-2 CFMW-045a-SO-0	460-118613-3 CFMW-045a-SO-0	460-118613-4 CFMW-045a-SO-0	460-115886-20 CFMW-047-SO-0	460-116014-1 CFMW-047-SO-0	460-115886-21 CFMW-047-SO-10	460-115886-22 CFMW-047-SO-10	460-119134-1 CFMW-049-SO-0	460-119134-7 CFMW-049a-SO-0	460-119134-2 CFMW-049a-SO-0	460-119134-3 CFMW-049a-SO-0	460-116014-7 CFMW-050-SO-0	460-116014-8 CFMW-050-SO-0	460-116014-10 CFMW-DUP17-SO
Sample Name	10-12	0.5	0.5-2	0.5-2 ft	10-12	0.5	0.5-2	12	0.5	0.5 Pb	0.5-2	10-12	0.5	0.5-2	0.5-2 ft
Sample Depth	10-12 ft	0-0.5 ft	0.5-2 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0-0.5 ft	10-12 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	10-12 ft	0-0.5 ft	0-0.5 ft	0.5-2 ft
Chemical	7/20/2016	8/12/2016	8/12/2016	8/12/2016	6/21/2016	6/21/2016	6/21/2016	6/21/2016	8/20/2016	8/20/2016	8/20/2016	8/20/2016	6/22/2016	6/22/2016	6/22/2016

GENERAL CHEMISTRY|ANIONS (mg/kg)

Fluoride	4.02 J+	74.8 J	65.3 J	16.7 J	22.2 J	--	36.2 J	3.73 J	11.4 J+	--	10.9 J+	2.91 J+	21.2 J+	--	26 J+	33 J+
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-1b
Main Plant Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-050	CFMW-053A	CFMW-053A	CFMW-053A	CFMW-053A-DUP	CFMW-053A	CFMW-054	CFMW-054	CFMW-054
Sample Lab IDs	460-116014-9 CFMW-050-SO-10	460-118952-2 CFMW-053a-SO-0	460-118952-3 CFMW-053a-SO-0	460-118952-4 0.5Pb	460-118952-6 0.5-2	460-118952-5 CFMW-053a-SO-10	460-115886-3 0.5	460-115886-4 CFMW-054-SO-0	460-115886-5 CFMW-054-SO-10
Sample Name	12	0.5	0-0.5 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	12
Sample Depth	10-12 ft 6/22/2016	0-0.5 ft 8/17/2016	8/17/2016	8/17/2016	8/17/2016	8/17/2016	6/20/2016	6/20/2016	6/20/2016
Chemical									

GENERAL CHEMISTRY | ANIONS (mg/kg)

Fluoride	2.7 J+	8.82	—	8.47 J	3.85 J	3.87	231 J	355 J	14 J
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-2a North Percolation Pond Area Soil (0-2 ft-bgs) Data Used in Human Health Risk Assessment Columbia Falls Aluminum Facility Columbia Falls, Montana																	
Sample Location ID	CFMW-027	CFMW-027	CFSB-014	CFSB-014	CFSB-016	CFSB-016	CFSB-019	CFSB-019	CFSB-019-DUP	CFSB-025	CFSB-025	CFSB-026	CFSB-026	CFSB-027	CFSB-027	CFSB-027	CFSB-028
Sample Lab IDs	460-116402-11	460-116402-12	460-114828-33	460-114828-37	460-114828-25	460-114828-35	460-115008-10	460-115008-11	460-115008-12	460-115528-18	460-115528-15	460-115528-16	460-115528-11	460-115528-22	460-115528-19	460-115528-21	460-117381-1
Sample Name	0.5	0.5-2	0.5	2	0.5	2	0.5	2	0.5	2	0.5	2	0.5	2	0.5	2	0.5
Sample Depth	0-0.5 ft	0.5-2 ft	0-0.5 ft														
Chemical	6/30/2016	6/30/2016	6/2/2016	6/2/2016	6/2/2016	6/2/2016	6/4/2016	6/4/2016	6/4/2016	6/13/2016	6/13/2016	6/13/2016	6/13/2016	6/13/2016	6/13/2016	6/13/2016	7/18/2016
GENERAL CHEMISTRY ANIONS (mg/kg)																	
Fluoride	149 J+	58.8 J+	33.6 J	7.98 J	241 J	54.3 J	50 J	48.2 J	50.2 J	138 J-	154 J-	167 J-	258 J+	52.8 J-	81.5 J-	94.8 J+	

Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-2a
North Percolation Pond Area Soil (0-2 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-028 460-117381-2 CFSB-028-SO-0.5-	CFSB-030 460-115528-20 CFSB-030-SO-0-	CFSB-030 460-115528-23 CFSB-030-SO-0.5-
Sample Name	2	0.5	2
Sample Depth	0.5-2 ft	0-0.5 ft	0.5-2 ft
Chemical	7/18/2016	6/13/2016	6/13/2016
GENERAL CHEMISTRY ANIONS (mg/kg)			
Fluoride	23.8 J+	221 J+	84 J-

Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-2b
North Percolation Pond Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-027	CFMW-027	CFMW-027	CFSB-014	CFSB-014	CFSB-014	CFSB-016	CFSB-016	CFSB-016	CFSB-019	CFSB-019	CFSB-019-DUP	CFSB-019	CFSB-025	CFSB-025	
Sample Lab IDs	460-116402-11	460-116402-12	460-116402-13	460-114828-33	460-114828-37	460-114828-38	460-114828-25	460-114828-35	460-114828-26	460-115008-10	460-115008-11	460-115008-12	460-115528-13	460-115528-18	460-115528-15	
Sample Name	CFMW-027-SO-0-	CFMW-027-SO-0-	CFMW-027-SO-10-	CFSB-014-SO-0-	CFSB-014-SO-0.5-	CFSB-014-SO-10-	CFSB-016-SO-0-	CFSB-016-SO-0.5-	CFSB-016-SO-10-	CFSB-019-SO-0-	CFSB-019-SO-0.5-	CFSB-019-SO-10-	CFSB-019-SO-10-	CFSB-025-SO-0-	CFSB-025-SO-0.5-	
Sample Depth	0.5	2	12	0.5 ft	0.5 ft	2	12	0.5 ft	12	0.5 ft	2	12	0.5 ft	0.5 ft	12	12
Chemical	0-0.5 ft	0.5-2 ft	10-12 ft	6/30/2016	6/2/2016	0.5-2 ft	10-12 ft	6/2/2016	10-12 ft	0-0.5 ft	0.5-2 ft	0.5-2 ft	0.5-2 ft	0-0.5 ft	0.5 ft	10-12 ft
GENERAL CHEMISTRY ANIONS (mg/kg)																
Fluoride	149 J+	58.8 J+	44.7 J+	33.6 J	7.98 J	0.87 J	241 J	54.3 J	3.9 J	50 J	48.2 J	50.2 J	20.9 J-	138 J-	154 J-	34.4 J-

Footnotes:

- = not applicable
- = Result is biased low
- + = Result is biased high
- ft = feet
- ft-bgs = feet below ground surface
- J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- mg/kg = milligram(s) per kilogram

Appendix A-2b
North Percolation Pond Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-026	CFSB-026	CFSB-026	CFSB-027	CFSB-027	CFSB-027	CFSB-028	CFSB-028	CFSB-028	CFSB-030	CFSB-030	CFSB-030
Sample Lab IDs	460-115528-16	460-115528-11	460-115528-14	460-115528-22	460-115528-19	460-115528-17	460-117381-1	460-117381-2	460-117381-3	460-115528-20	460-115528-23	460-115528-21
Sample Name	CFSB-026-SO-0-	CFSB-026-SO-0.5-	CFSB-026-SO-10-	CFSB-027-SO-0-	CFSB-027-SO-0.5-	CFSB-027-SO-10-	CFSB-028-SO-0-	CFSB-028-SO-0.5-	CFSB-028-SO-10-	CFSB-030-SO-0-	CFSB-030-SO-0.5-	CFSB-030-SO-10-
Sample Depth	0.5 0-0.5 ft	2 0.5-2 ft	12 10-12 ft	0.5 0-0.5 ft	2 0.5-2 ft	12 10-12 ft	0.5 0-0.5 ft	2 0.5-2 ft	12 10-12 ft	0.5 0-0.5 ft	2 0.5-2 ft	12 10-12 ft
Chemical	6/13/2016	6/13/2016	6/13/2016	6/13/2016	6/13/2016	6/13/2016	7/18/2016	7/18/2016	7/18/2016	6/13/2016	6/13/2016	6/13/2016
GENERAL CHEMISTRY ANIONS (mg/kg)												
Fluoride	167 J-	258 J+	26.1 J-	52.8 J-	81.5 J-	49.1 J-	94.8 J+	23.8 J+	19 J+	221 J+	84 J-	10.3 J-

Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-2c
North Percolation Pond Area (surface water)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSWP-023	CFSWP-024
Sample Lab IDs	460-130874-1	460-135444-5
Sample Name	CFSWP-023-SW	CFSWP-024-SW
Chemical	4/3/2017	6/15/2017
GENERAL CHEMISTRY ANIONS (µg/L)		
Fluoride	2150	22400 J+

Footnotes:

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

µg/L = microgram(s) per liter

Appendix A-2d
North Percolation Pond Area (sediment)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSDP-023 200-35201-11,	CFSDP-023-DUP 460-119830-6	CFSDP-024 200-35201-12, 460-119830-2
Sample Lab IDs			
Sample Name	CFSDP-023-SD	CFSDP-DUP2-SD	CFSDP-024-SD
Chemical	9/7/2016	9/7/2016	9/7/2016
GENERAL CHEMISTRY ANIONS (mg/kg)			
Fluoride	56.6 J	59.3 J	219

Footnotes:

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-3a
Central Landfill Area Soil (0-0.5 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-023A	CFSB-001	CFSB-002	CFSB-003	CFSB-004	CFSB-005	CFSB-006	CFSB-007	CFSB-008	CFSB-009	CFSB-009-DUP	CFSB-021	CFSB-022	CFSB-029	CFSB-033	CFSB-034
Sample Lab IDs	460-115731-9	460-114529-4	460-114529-7	460-114529-10	460-114529-1	460-114529-15	460-114456-18	460-114529-14	460-114456-20	460-114456-15	460-114456-24	460-114456-12	460-114456-6	460-114456-4	460-114456-5	460-114793-52
Sample Name	CFMW-023a-SO-0-	CFSB-001-SO-0-	CFSB-002-SO-0-	CFSB-003-SO-0-	CFSB-004-SO-0-	CFSB-005-SO-0-	CFSB-006-SO-0-	CFSB-007-SO-0-	CFSB-008-SO-0-	CFSB-009-SO-0-	CFSB-DUP6-SO	CFSB-021-SO-0-	CFSB-022-SO-0-	CFSB-029-SO-0-	CFSB-033-SO-0-	CFSB-034-SO-0-
Sample Depth	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Chemical	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft
GENERAL CHEMISTRY ANIONS (mg/kg)																
Fluoride	109 J-	56.5 J	22.4 J	26.9 J	34.1 J	11.6 J	14.6 J	11.8 J	30.6 J	37.6 J	37.9 J+	89.9 J	28.9 J	62 J	95.8 J	210 J-

Footnotes:

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-3a
Central Landfill Area Soil (0-0.5 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-035 460-114793-45	CFSB-036 460-114793-48	CFSB-037 460-114793-49	CFMW-012A 460-114275-1	CFMW-019A 460-114456-49	CFMW-002 460-115528-7	CFMW-008A 460-115528-1	CFMW-010 460-114141-16	CFMW-016A 460-115886-11	CFMW-018 460-114141-34	CFMW-022 460-114828-29	CFMW-029 460-114141-13
Sample Lab IDs	CFSB-035-SO-0- 0.5	CFSB-036-SO-0- 0.5	CFSB-037-SO-0- 0.5	CFMW-012A-SO-0- 0.5	CFMW-019a-SO-0- 0.5	CFMW-002-SO-0- 0.5	CFMW-008a-SO-0- 0.5	CFMW-010-SO-0- 0.5	CFMW-016a-SO-0- 0.5	CFMW-018-SO-0- 0.5	CFMW-022-SO-0- 0.5	CFMW-029-SO-0- 0.5
Sample Name												
Sample Depth	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft				
Chemical	5/31/2016	5/31/2016	5/31/2016	5/20/2016	5/25/2016	6/13/2016	6/13/2016	5/18/2016	6/21/2016	5/19/2016	6/2/2016	5/18/2016

GENERAL CHEMISTRY|ANIONS (mg/kg)

Fluoride	180 J	86.8 J	19.4 J	91.9 J-	37 J-	56.7 J-	84.9 J-	114 J-	59.4 J	9.33 J-	17.5 J	105 J-
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Footnotes:

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-3b
Central Landfill Area Soil (0-2 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-023A	CFMW-023A	CFSB-001	CFSB-001	CFSB-002	CFSB-002	CFSB-003	CFSB-003	CFSB-004	CFSB-004	CFSB-005	CFSB-005	CFSB-006	CFSB-006	CFSB-007	CFSB-007
Sample Lab IDs	460-115731-9	460-115731-10	CFMW-023a-SO-0-	CFSB-001-SO-0-	460-114529-4	460-114529-5	460-114529-7	460-114529-8	460-114529-10	460-114529-11	460-114529-15	460-114529-17	460-114456-18	460-114456-22	460-114529-14	460-114529-16
Sample Name	0.5	0.5-2	0.5	0.5	2	0.5	2	0.5	2	0.5	2	2	0.5	2	0.5	2
Sample Depth	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft
Chemical	6/17/2016	6/17/2016	5/25/2016	5/25/2016	5/25/2016	5/25/2016	5/25/2016	5/25/2016	5/25/2016	5/25/2016	5/25/2016	5/25/2016	5/23/2016	5/23/2016	5/25/2016	5/25/2016
GENERAL CHEMISTRY ANIONS (mg/kg)																
Fluoride	109 J-	58.5	56.5 J	53.7 J	22.4 J	28 J	26.9 J	16.3 J	34.1 J	39 J	11.6 J	20.4 J	14.6 J	5.6 J+	11.8 J	25 J

Footnotes:

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-3b
Central Landfill Area Soil (0-2 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-008 460-114456-20	CFSB-008 460-114456-17	CFSB-008-DUP 460-114456-19	CFSB-009 460-114456-15	CFSB-009 460-114456-13	CFSB-009-DUP 460-114456-24	CFSB-021 460-114456-12	CFSB-021 460-114456-9	CFSB-022 460-114456-6	CFSB-022 460-114456-7	CFSB-029 460-114456-4	CFSB-029 460-114456-3	CFSB-033 460-114456-5	CFSB-033 460-114456-10	CFSB-034 460-114793-52	CFSB-034 460-114793-51
Sample Lab IDs	CFSB-008-SO-0- CFSB-008-SO-0.5-	CFSB-008-SO-0- CFSB-008-SO-0.5-	CFSB-DUP4-SO 0.5-2 ft	CFSB-DUP4-SO 0.5-2 ft	CFSB-009-SO-0- CFSB-009-SO-0.5-	CFSB-009-SO-0- CFSB-009-SO-0.5-	CFSB-021-SO-0- CFSB-021-SO-0.5-	CFSB-021-SO-0- CFSB-021-SO-0.5-	CFSB-022-SO-0- CFSB-022-SO-0.5-	CFSB-022-SO-0- CFSB-022-SO-0.5-	CFSB-029-SO-0- CFSB-029-SO-0.5-	CFSB-029-SO-0- CFSB-029-SO-0.5-	CFSB-033-SO-0- CFSB-033-SO-0.5-	CFSB-033-SO-0- CFSB-033-SO-0.5-	CFSB-034-SO-0- CFSB-034-SO-0.5-	CFSB-034-SO-0- CFSB-034-SO-0.5-
Sample Name	0.5	2		0.5	2		0.5	2	0.5	2	0.5	2	0.5	2	0.5	2
Sample Depth	0-0.5 ft	0.5-2 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft									
Chemical	5/23/2016	5/23/2016	5/23/2016	5/23/2016	5/23/2016	5/24/2016	5/23/2016	5/23/2016	5/23/2016	5/23/2016	5/23/2016	5/23/2016	5/23/2016	5/23/2016	5/23/2016	5/31/2016

GENERAL CHEMISTRY | ANIONS (mg/kg)

Fluoride	30.6 J	16.2 J	45.4 J	37.6 J	17.9 J	37.9 J+	89.9 J	81.1 J	28.9 J	24.7 J	62 J	21.7 J	95.8 J	75.3 J	210 J-	20.4 J
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Footnotes:

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-3b
Central Landfill Area Soil (0-2 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-035	CFSB-035	CFSB-036	CFSB-036	CFSB-037	CFSB-037	CFMW-012A	CFMW-012A-DUP	CFMW-019A	CFMW-019A	CFMW-019A-DUP	CFMW-002	CFMW-002	CFMW-008A	CFMW-008A	
Sample Lab IDs	460-114793-45	460-114793-46	460-114793-48	460-114793-53	460-114793-49	460-114793-54	460-114275-1	460-114275-3	460-114456-49	460-114456-50	460-114456-52	460-115528-7	460-115528-8	460-115528-1	460-115528-3	
Sample Name	0.5	2	0.5	2	0.5	2	0.5	0.5-2	0.5	0.5-2	0.5	0.5-2	0.5	0.5	0.5-2	
Sample Depth	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5	0.5-2 ft	
Chemical	5/31/2016	5/31/2016	5/31/2016	5/31/2016	5/31/2016	5/31/2016	5/20/2016	5/20/2016	5/25/2016	5/25/2016	5/25/2016	6/13/2016	6/13/2016	6/13/2016	6/13/2016	
GENERAL CHEMISTRY ANIONS (mg/kg)																
Fluoride	180 J	116 J	86.8 J	104 J-	19.4 J	15.5 J	91.9 J-	59.3 J-	80.8 J-	37 J-	62.2 J-	44.2 J-	56.7 J-	166 J+	84.9 J-	180 J+

Footnotes:

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-3b
Central Landfill Area Soil (0-2 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-010 460-114141-16	CFMW-010 460-114141-17	CFMW-016A 460-115886-11	CFMW-016A 460-115886-12	CFMW-018 460-114141-34	CFMW-018 460-114141-35	CFMW-022 460-114828-29	CFMW-022 460-114828-28	CFMW-022-DUP 460-114828-30	CFMW-029 460-114141-13	CFMW-029 460-114141-14
Sample Lab IDs	CFMW-010-SO-0- 0.5	CFMW-010-SO- 0.5-2.0	CFMW-016a-SO-0- 0.5	CFMW-016a-SO- 0.5-2	CFMW-018-SO-0- 0.5	CFMW-018-SO- 0.5-2.0	CFMW-022-SO-0- 0.5	CFMW-022-SO- 0.5-2	CFMW-DUP12-SO- 0.5-2 ft	CFMW-029-SO-0- 0.5	CFMW-029-SO- 0.5-2.0
Sample Name											
Sample Depth	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0-0.5 ft	0.5-2 ft
Chemical	5/18/2016	5/18/2016	6/21/2016	6/21/2016	5/19/2016	5/19/2016	6/2/2016	6/2/2016	6/2/2016	5/18/2016	5/18/2016
GENERAL CHEMISTRY ANIONS (mg/kg)											
Fluoride	114 J-	101 J-	59.4 J	25.4 J	9.33 J-	7.71 J-	17.5 J	9.45 J*	10.1 J	105 J-	50.3 J-

Footnotes:

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-3c
Central Landfill Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-023A	CFMW-023A	CFMW-023A	CFSB-001	CFSB-001	CFSB-001	CFSB-002	CFSB-002	CFSB-002	CFSB-003	CFSB-003	CFSB-003	CFSB-004	CFSB-004	CFSB-004	
Sample Lab IDs	460-115731-9	460-115731-10	460-115731-11	460-114529-4	460-114529-5	460-114529-6	460-114529-7	460-114529-8	460-114529-9	460-114529-10	460-114529-11	460-114529-13	460-114529-1	460-114529-2	460-114529-3	460-114529-15
Sample Name	CFMW-023a-SO-0-	CFMW-023a-SO-	CFMW-023a-SO-	CFSB-001-SO-0-	CFSB-001-SO-0.5-	CFSB-001-SO-10-	CFSB-002-SO-0-	CFSB-002-SO-0.5-	CFSB-002-SO-10-	CFSB-003-SO-0-	CFSB-003-SO-0.5-	CFSB-003-SO-10-	CFSB-004-SO-0-	CFSB-004-SO-0.5-	CFSB-004-SO-10-	CFSB-005-SO-0-
Sample Depth	0.5	0.5-2	10-12	0.5	0.5	2	12	0.5	2	12	0.5	2	12	0.5	2	0.5
Chemical	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	5/25/2016	5/25/2016	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0.5-2 ft	10-12 ft	0-0.5 ft
GENERAL CHEMISTRY ANIONS (mg/kg)																
Fluoride	109 J-	58.5	3.69	56.5 J	53.7 J	11.6 J	22.4 J	28 J	4.27 J	26.9 J	16.3 J	0.35 J	34.1 J	39 J	10.3 J	11.6 J

Footnotes:

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-3c
Central Landfill Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID Sample Lab IDs	CFSB-005 460-114529-17 CFSB-005-SO-0.5-	CFSB-005 460-114529-12 CFSB-005-SO-10-	CFSB-006 460-114456-18 CFSB-006-SO-0-	CFSB-006 460-114456-22 CFSB-006-SO-0.5-	CFSB-006 460-114456-16 CFSB-006-SO-10-	CFSB-007 460-114529-14 CFSB-007-SO-0-	CFSB-007 460-114529-16 CFSB-007-SO-0.5-	CFSB-007 460-114529-18 CFSB-007-SO-10-	CFSB-008 460-114456-20 CFSB-008-SO-0-	CFSB-008 460-114456-17 CFSB-008-SO-0.5-	CFSB-008-DUP 460-114456-19 CFSB-008-SO-10-	CFSB-008 460-114456-21 CFSB-008-SO-1-	CFSB-009 460-114456-15 CFSB-009-SO-0-	CFSB-009 460-114456-13 CFSB-009-SO-0.5-	CFSB-009 460-114456-14 CFSB-009-SO-10-	CFSB-009-DUP 460-114456-24 CFSB-DUP6-SO
Sample Name Sample Depth Chemical	2 0.5-2 ft 5/25/2016	12 10-12 ft 5/25/2016	0.5 0-0.5 ft 5/23/2016	2 0.5-2 ft 5/23/2016	12 10-12 ft 5/23/2016	0.5 0-0.5 ft 5/25/2016	2 0.5-2 ft 5/25/2016	12 10-12 ft 5/25/2016	0.5 0-0.5 ft 5/23/2016	2 0.5-2 ft 5/23/2016	0.5 0-0.5 ft 5/23/2016	12 0.5-2 ft 5/23/2016	0.5 10-12 ft 5/23/2016	2 0.5-2 ft 5/23/2016	12 10-12 ft 5/23/2016	0.5 0-0.5 ft 5/24/2016
GENERAL CHEMISTRY ANIONS (mg/kg)																
Fluoride	20.4 J	4.23 J	14.6 J	5.6 J+	12.5 J	11.8 J	25 J	1.52 J	30.6 J	16.2 J	45.4 J	8.58 J+	37.6 J	17.9 J	4.63 J	37.9 J+

Footnotes:

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-3c
Central Landfill Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-021	CFSB-021	CFSB-021	CFSB-022	CFSB-022	CFSB-022	CFSB-029	CFSB-029	CFSB-029	CFSB-033	CFSB-033	CFSB-033	CFSB-034	CFSB-034	CFSB-034	
Sample Lab IDs	460-114456-12	460-114456-9	460-114456-1	460-114456-6	460-114456-7	460-114456-11	460-114456-4	460-114456-3	460-114456-8	460-114456-5	460-114456-10	460-114456-2	460-114456-2	460-114793-52	460-114793-51	460-114793-45
Sample Name	CFSB-021-SO-0-	CFSB-021-SO-0.5-	CFSB-021-SO-10-	CFSB-021-SO-0-	CFSB-022-SO-0-	CFSB-022-SO-10-	CFSB-029-SO-0-	CFSB-029-SO-0.5-	CFSB-029-SO-10-	CFSB-033-SO-0-	CFSB-033-SO-0.5-	CFSB-033-SO-10-	CFSB-034-SO-0-	CFSB-034-SO-0.5-	CFSB-034-SO-10-	CFSB-035-SO-0-
Sample Depth	0.5	2	12	0.5	2	12	0.5	2	12	0.5	2	12	0.5	2	12	0.5
Chemical	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft
GENERAL CHEMISTRY ANIONS (mg/kg)																
Fluoride	89.9 J	81.1 J	16.8 J	28.9 J	24.7 J	25.9 J	62 J	21.7 J	57.1 J	95.8 J	75.3 J	12.4 J	210 J-	20.4 J	32.9 J	180 J

Footnotes:

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-3c
Central Landfill Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-035	CFSB-035	CFSB-036	CFSB-036	CFSB-036	CFSB-037	CFSB-037	CFSB-037	CFMW-012A	CFMW-012A	CFMW-012A-DUP	CFMW-012A	CFMW-019A	CFMW-019A	CFMW-019A-DUP	CFMW-019A
Sample Lab IDs	460-114793-46	460-114793-57	460-114793-48	460-114793-53	460-114793-50	460-114793-49	460-114793-54	460-114793-47	460-114275-1	460-114275-3	460-114275-5	460-114275-4	460-114456-49	460-114456-50	460-114456-52	460-114456-51
Sample Name	CFSB-035-SO-0.5-	CFSB-035-SO-10-	CFSB-036-SO-0-	CFSB-036-SO-0.5-	CFSB-036-SO-10-	CFSB-037-SO-0-	CFSB-037-SO-0.5-	CFSB-037-SO-10-	CFMW-012A-SO-0	CFMW-012A-SO-	CFMW-012A-SO-3	CFMW-012A-SO-	CFMW-019a-SO-0	CFMW-019a-SO-	CFMW-019a-SO-	CFMW-019a-SO-
Sample Depth	2	12	0.5	2	12	0.5	2	12	0.5	0.5-2	0.5-2	0.5-2	0.5	0.5-2	0.5-2	0.5-2
Chemical	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	0.5-2 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0.5-2 ft	0.5-2 ft
GENERAL CHEMISTRY ANIONS (mg/kg)																
Fluoride	116 J	35.2 J	86.8 J	104 J-	28.3 J	19.4 J	15.5 J	5.64 J	91.9 J-	59.3 J-	80.8 J-	13.7 J-	37 J-	62.2 J-	44.2 J-	1.3 J-

Footnotes:

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-3c
Central Landfill Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-002 460-115528-7	CFMW-002 460-115528-8	CFMW-002 460-115528-9	CFMW-008A 460-115528-1	CFMW-008A 460-115528-3	CFMW-008A-DUP 460-115528-5	CFMW-010 460-114141-16	CFMW-010 460-114141-17	CFMW-010 460-114141-18	CFMW-016A 460-115886-11	CFMW-016A 460-115886-12	CFMW-016A 460-115886-13	CFMW-018 460-114141-34	CFMW-018 460-114141-35	CFMW-018 460-114141-36
Sample Lab IDs	CFMW-002-SO-0- CFMW-002-SO-0-	CFMW-002-SO-0- CFMW-002-SO-10	CFMW-002-SO-10- CFMW-008a-SO-0-	CFMW-008a-SO-0- CFMW-008a-SO-	CFMW-008a-SO-0- CFMW-008a-SO-	CFMW-010-SO-0- CFMW-DUP14-SO	CFMW-010-SO-0- 10-12 ft	CFMW-010-SO-0- 10-12 ft	CFMW-010-SO-0- 10-12 ft	CFMW-016a-SO-0- 0.5 ft	CFMW-016a-SO-0- 0.5 ft	CFMW-016a-SO-0- 0.5 ft	CFMW-018-SO-0- 10-12 ft	CFMW-018-SO-0- 0.5 ft	CFMW-018-SO-0- 12 ft
Sample Name	0.5	0.5-2	12	0.5	0.5-2	10-12	0.5-2.0	12	0.5	0.5-2	10-12	0.5-2.0	10-12	0.5-2.0	12
Sample Depth	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	10-12 ft	0-0.5 ft	10-12 ft
Chemical	6/13/2016	6/13/2016	6/13/2016	6/13/2016	6/13/2016	6/13/2016	5/18/2016	5/18/2016	5/18/2016	6/21/2016	6/21/2016	6/21/2016	5/19/2016	5/19/2016	5/19/2016

GENERAL CHEMISTRY|ANIONS (mg/kg)

Fluoride	56.7 J-	166 J+	10.2 J-	84.9 J-	180 J+	3.98 J-	3.25 J-	114 J-	101 J-	11.6 J-	59.4 J	25.4 J	6.29 J	9.33 J-	7.71 J-	4.07 J-
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Footnotes:

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-3c
Central Landfill Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID Sample Lab IDs	CFMW-018-DUP 460-114141-37	CFMW-022 460-114828-29	CFMW-022 460-114828-28	CFMW-022-DUP 460-114828-30	CFMW-022 460-114828-27	CFMW-029 460-114141-13	CFMW-029 460-114141-14	CFMW-029 460-114141-15
Sample Name Sample Depth	CFMW-DUP2-SO 10-12 ft	0.5	0.5-2	CFMW-DUP12-SO 0.5-2 ft	12	0.5	0.5-2.0	SO-10-12
Chemical	5/19/2016	6/2/2016	6/2/2016	6/2/2016	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft
GENERAL CHEMISTRY ANIONS (mg/kg)								
Fluoride	4.03 J-	17.5 J	9.45 J	10.1 J	63.3 J	105 J-	50.3 J-	9.6 J-

Footnotes:

- = Result is biased low
+ = Result is biased high
ft = feet
ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
mg/kg = milligram(s) per kilogram

Appendix A-3d

Central Landfill Area (surface water)
 Data Used in Human Health Risk Assessment
 Columbia Falls Aluminum Facility
 Columbia Falls, Montana

Sample Location ID	CFSWP-010	CFSWP-010	CFSWP-010	CFSWP-011	CFSWP-011	CFSWP-011	CFSWP-012	CFSWP-012	CFSWP-012-DUP	CFSWP-012
Sample Lab IDs	460-114997-2	460-129899-2	460-135182-2	460-114997-3	460-130874-6	460-135182-3	460-114997-4	460-130874-7	460-130874-8	460-135182-4
Sample Name	CFSWP-010-SW	CFSWP-010-SW	CFSWP-010-SW	CFSWP-011-SW	CFSWP-011-SW	CFSWP-011-SW	CFSWP-012-SW	CFSWP-012-SW	CFSWP-DUP5-SW	CFSWP-012-SW
Chemical	6/7/2016	3/15/2017	6/12/2017	6/7/2016	4/3/2017	6/12/2017	6/7/2016	4/3/2017	4/3/2017	6/12/2017
GENERAL CHEMISTRY ANIONS (µg/L)										
Fluoride	39.4 J	2600	181	38.7 J	103	131	39.5 J	101	89.6	131

Footnotes:

J = The analyte was positively identified; the associated numerical value

µg/L = microgram(s) per liter

Appendix A-3e
Central Landfill Area (sediment)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSDP-010 200-35201-5, 460- 119741-2	CFSDP-011 200-35201-6, 460- 119741-3	CFSDP-012 200-35201-7, 460- 119741-4	CFSDP-012-DUP 460-119741-6
Sample Lab IDs	CFSDP-010-SO	CFSDP-011-SO	CFSDP-012-SO	CFSDP-DUP1-SO
Sample Name				
Sample Depth	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft
Chemical	9/6/2016	9/6/2016	9/6/2016	9/6/2016
GENERAL CHEMISTRY ANIONS (mg/kg)				
Fluoride	4.27	1.62	1.3	1.57

Footnotes:

ft = feet

mg/kg = milligram(s) per kilogram

Appendix A-4a
Industrial Landfill Area Soil (0-0.5 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-003A
Sample Lab IDs	460-114793-37
Sample Name	CFMW-003a-SO-0-0.5
Sample Depth	0-0.5 ft
Chemical	5/31/2016
GENERAL CHEMISTRY ANIONS (mg/kg)	
Fluoride	4.17 J

Footnotes:

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-4b
Industrial Landfill Area Soil (0-2 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-003A	CFMW-003A
Sample Lab IDs	460-114793-37	460-114793-39
Sample Name	CFMW-003a-SO-0-0.5	CFMW-003a-SO-0.5-2
Sample Depth	0-0.5 ft	0.5-2 ft
Chemical	5/31/2016	5/31/2016
GENERAL CHEMISTRY ANIONS (mg/kg)		
Fluoride	4.17 J	37.8 J-

Footnotes:

- = Result is biased low

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-4c
Industrial Landfill Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-003A	CFMW-003A	CFMW-003A	CFMW-003A-DUP
Sample Lab IDs	460-114793-37	460-114793-39	460-114793-40	460-114793-38
Sample Name	CFMW-003a-SO-0-	CFMW-003a-SO-	CFMW-003a-SO-	CFMW-DUP9-SO
Sample Depth	0.5	0.5-2	10-12	10-12 ft
Chemical	0-0.5 ft	0.5-2 ft	10-12 ft	5/31/2016
GENERAL CHEMISTRY ANIONS mg/kg)				
Fluoride	4.17 J	37.8 J-	2.76 J	3.31 J-

Footnotes:

- = Result is biased low

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-5a
Eastern Undeveloped Area (surface water)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSWP-009	CFSWP-009	CFSWP-009
Sample Lab IDs	460-114997-1	460-130874-5	460-135182-1
Sample Name Chemical	CFSWP-009-SW 6/7/2016	CFSWP-009-SW 4/3/2017	CFSWP-009-SW 6/12/2017
GENERAL CHEMISTRY ANIONS (µg/L)			
Fluoride	80.3	105	188

Footnotes:

µg/L = microgram(s) per liter

Appendix A-5b
Eastern Undeveloped Area (sediment)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSDP-009 200-35201-4, 460-
Sample Lab IDs	119741-1
Sample Name	CFSDP-009-SO
Sample Depth	0-0.5 ft
Chemical	9/6/2016
GENERAL CHEMISTRY ANIONS	
Fluoride	1.62

Footnotes:

ft = feet

mg/kg = milligram(s) per kilogram

Appendix A-6a
North Central Undeveloped Area Soil (0-0.5 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-011	CFMW-011A	CFSB-013	CFSB-122
Sample Lab IDs	460-114141-41	460-116119-10	460-114141-	460-114141-28
	CFSB-011-SO-0-	CFMW-011a-SO-0-	CFSB-013-SO-	CFSB-122-SO-0-
Sample Name	0.5	0.5	0-0.5	0.5
Sample Depth	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft
Chemical	5/19/2016	6/25/2016	5/19/2016	5/19/2016
GENERAL CHEMISTRY ANIONS (mg/kg)				
Fluoride	8.33 J-	27.6 J+	15.8 J-	12.2 J-

Footnotes:

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-6b
North Central Undeveloped Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-011	CFSB-011	CFSB-011	CFMW-011A	CFMW-011A	CFMW-011A-DUP	CFMW-011A	CFSB-013	CFSB-013	CFSB-013	CFSB-122	CFSB-122	CFSB-122
Sample Lab IDs	460-114141-41	460-114141-42	460-114141-43	460-116119-10	460-116119-11	460-116119-13	460-116119-12	460-114141-	460-114141-	460-114141-	460-114141-28	460-114141-29	460-114141-30
Sample Name	0.5	2.0	12	0.5	0.5-2	CFMW-Dup18-SO	10-12	0-0.5	0.5-2.0	10-12	0.5	2.0	12
Sample Depth	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	6/25/2016	6/25/2016	6/25/2016	5/19/2016	5/19/2016	5/19/2016	5/19/2016	5/19/2016
Chemical	5/19/2016	5/19/2016	5/19/2016	6/25/2016	6/25/2016		6/25/2016	5/19/2016	5/19/2016	5/19/2016	5/19/2016	5/19/2016	5/19/2016
GENERAL CHEMISTRY ANIONS (mg/kg)													
Fluoride	8.33 J-	11.2 J-	7.87 J-	27.6 J+	12 J+	10.1 J+	5.08 J+	15.8 J-	8 J-	1.57 J-	12.2 J-	5.57 J-	0.57 J-

Footnotes:

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-6c

North Central Undeveloped Area (surface water)

Data Used in Human Health Risk Assessment

Columbia Falls Aluminum Facility

Columbia Falls, Montana

Sample Location ID Sample Lab IDs Sample Name Chemical	CFSWP-013 460-114997-5 CFSWP-013-SW 6/7/2016	CFSWP-013-DUP 460-114997-6 CFSWP-DUP1-SW 6/7/2016	CFSWP-013 460-124553-1 CFSWP-013-SW 11/30/2016	CFSWP-013 460-129899-3 CFSWP-013-SW 3/15/2017	CFSWP-013 460-135182-5 CFSWP-013-SW 6/12/2017	CFSWP-021 460-114944-4 CFSWP-021-SW 6/6/2016	CFSWP-021 460-124553-7 CFSWP-021-SW 11/30/2016	CFSWP-021 460-129899-1 CFSWP-021-SW 3/15/2017	CFSWP-021 460-135444-4 CFSWP-021-SW 6/15/2017	CFSWP-022 460-114944-5 CFSWP-022-SW 6/6/2016	CFSWP-022 460-130874-2 CFSWP-022-SW 4/3/2017
GENERAL CHEMISTRY ANIONS (µg/L)											
Fluoride	39.2 J	38.3 J	473 J-	308	131	166	189 J-	231	243	177	223

Footnotes:

- = Result is biased low

J = The analyte was positively identified; the associated numerical value

µg/L = microgram(s) per liter

Appendix A-6d
North Central Undeveloped Area (sediment)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSDP-013 200-35201-8, 460- 119741-5	CFSDP-021 200-35201-9, 460- 119741-7	CFSDP-022 200-35201-10, 460-119741-8
Sample Lab IDs	CFSDP-013-SO	CFSDP-021-SO	CFSDP-022-SO
Sample Name	0-0.5 ft	0-0.5 ft	0-0.5 ft
Sample Depth	9/6/2016	9/6/2016	9/6/2016
GENERAL CHEMISTRY ANIONS (mg/kg)			
Fluoride	1.81	2.6	3.79

Footnotes:

J = The analyte was positively identified; the associated numerical value is the approximate
mg/kg = milligram(s) per kilogram

Appendix A-7a
Western Undeveloped Area Soil (0-0.5 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-056A	CFMW-056A-DUP	CFMW-057A	CFMW-059A	CFSB-120	CFSB-123	CFSB-124	CFSB-125	CFSB-126	CFSB-127	CFSB-132	CFSB-133
Sample Lab IDs	460-117203-2	460-117203-7	CFMW-056a-SO-0-	460-117886-1	460-117573-6	460-114141-10	460-114141-31	460-114141-25	460-114141-7	460-114141-1	460-115008-1	460-115008-4
Sample Name	0.5	CFMW-DUP20-SO	0.5	CFMW-057a-SO-0-	0.5	CFSB-120-SO-0-	CFSB-123-SO-0-	0.5	0.5	0.5	CFSB-127-SO-0-	CFSB-132-SO-0-
Sample Depth	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft
Chemical	7/15/2016	7/15/2016	7/27/2016	7/22/2016	5/18/2016	5/19/2016	5/19/2016	5/18/2016	5/18/2016	5/18/2016	6/3/2016	6/3/2016

GENERAL CHEMISTRY|ANIONS (mg/kg)

Fluoride	3.15 J	10.7 J	15.4	14.2	5.63 J	10.5 J-	10.8 J-	8.31 J-	6.31 J-	3.93 J-	1.78 J	2.4 J
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Footnotes:

- = Result is biased low

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-7b
Western Undeveloped Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFMW-056A	CFMW-056A-DUP	CFMW-056A	CFMW-056A	CFMW-057A	CFMW-057A	CFMW-057A	CFMW-059A	CFMW-059A	CFMW-059A	CFSB-120	CFSB-120	CFSB-120	CFSB-123	CFSB-123	CFSB-123
Sample Lab IDs	460-117203-2	460-117203-7	CFMW-DUP20-	460-117203-4	460-117203-5	460-117886-1	460-117886-2	460-117573-6	460-117573-7	460-117573-8	460-114141-10	460-114141-11	460-114141-12	460-114141-31	460-114141-32	460-114141-33
Sample Name	0.5	SO	0.5-2	0.5-2 ft	10-12	0.5	0.5-2	0.5	0.5-2	0.5	10-12	0.5	2.0	12	0.5	12
Sample Depth	0-0.5 ft	0-0.5 ft	0.5-2 ft	10-12 ft	7/15/2016	7/15/2016	7/27/2016	0-0.5 ft	0.5-2 ft	0.5	10-12 ft	0-0.5 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft
Chemical	7/15/2016	7/15/2016	7/15/2016	7/15/2016	7/27/2016	7/27/2016	7/27/2016	7/22/2016	7/22/2016	7/22/2016	5/18/2016	5/18/2016	5/18/2016	5/19/2016	5/19/2016	5/19/2016

GENERAL CHEMISTRY | ANIONS (mg/kg)

Fluoride	3.15 J	10.7 J	3.64 J+	2.27 J+	15.4	1.41	1.34	14.2	2.87	3.17	5.63 J	2.43 J-	0.43 J-	10.5 J-	9.29 J-	0.58 J-
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

UJ = The analyte was not deemed above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

Appendix A-7b
Western Undeveloped Area Soil (0-12 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-124 460-114141-25	CFSB-124 460-114141-26	CFSB-124 460-114141-27	CFSB-125 460-114141-4	CFSB-125 460-114141-5	CFSB-125 460-114141-6	CFSB-126 460-114141-7	CFSB-126 460-114141-8	CFSB-126 460-114141-9	CFSB-127 460-114141-1	CFSB-127 460-114141-2	CFSB-127 460-114141-3	CFSB-132 460-115008-1	CFSB-132 460-115008-2	CFSB-132 460-115008-3	CFSB-133 460-115008-4	CFSB-133 460-115008-5	CFSB-133 460-115008-6
Sample Lab IDs	CFSB-124-SO-0- CFSB-124-SO-0-5	CFSB-124-SO-0-5	CFSB-124-SO-10	CFSB-124-SO-0-	CFSB-125-SO-0-	CFSB-125-SO-10	CFSB-125-SO-0	CFSB-126-SO-	CFSB-126-SO-0	CFSB-127-SO-	CFSB-127-SO-0	CFSB-132-SO-0	CFSB-132-SO-0	CFSB-132-SO-	CFSB-133-SO-0	CFSB-133-SO-0	CFSB-133-SO-	
Sample Name	0.5	2.0	12	0.5	0.5-2.0	12	0.5	0.5-2.0	10-12	0.5	0.5-2.0	10-12	0.5	0.5-2	10-12	0.5	0.5-2	
Sample Depth	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	10-12 ft	0-0.5 ft	0.5-2 ft	
Chemical	5/19/2016	5/19/2016	5/19/2016	5/18/2016	5/18/2016	5/18/2016	5/18/2016	5/18/2016	5/18/2016	5/18/2016	5/18/2016	5/18/2016	6/3/2016	6/3/2016	6/3/2016	6/3/2016	6/3/2016	

GENERAL CHEMISTRY | ANIONS (mg/kg)

Fluoride	10.8 J-	6.61 J-	0.92 J-	8.31 J-	8.91 J-	0.97 J-	6.31 J-	5.3 J-	0.75 J-	3.93 J-	1.54 J-	2.61 J-	1.78 J	0.31 J	0.24 UJ	2.4 J	0.92 J	0.21 UJ
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

UJ = The analyte was not deemed above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

Appendix A-7c
Western Undeveloped Area (surface water)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID Sample Lab IDs	CFSWP-014 460-119361-1	CFSWP-014 460-124553-2	CFSWP-014-DUP 460-124553-5	CFSWP-014 460-129850-1	CFSWP-014-DUP 460-129850-5	CFSWP-014 460-135255-1	CFSWP-015 460-119361-2	CFSWP-015-DUP 460-119361-4	CFSWP-015 460-124553-3	CFSWP-015 460-125810-1	CFSWP-015 460-129850-2	CFSWP-015 460-135255-2
Sample Name Chemical	CFSWP-014-SW 8/29/2016	CFSWP-014-SW 11/30/2016	CFSWP-DUP3-SW 11/30/2016	CFSWP-014-SW 3/13/2017	CFSWP-Dup4-SW 3/13/2017	CFSWP-014-SW 3/13/2017	CFSWP-015-SW 6/13/2017	CFSWP-DUP2-SW 8/29/2016	CFSWP-015-SW 8/29/2016	CFSWP-015-SW 11/30/2016	CFSWP-015-SW 12/20/2016	CFSWP-015-SW 3/13/2017
GENERAL CHEMISTRY ANIONS (µg/L)												

Fluoride	55.8 J	117 J-	123 J-	126	134	137	62.4 J	62.3 J	119 J-	112 J-	129	135
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

µg/L = microgram(s) per liter

Appendix A-7c
Western Undeveloped Area (surface water)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSWP-015-DUP 460-135255-4	CFSWP-016 460-119361-3	CFSWP-016 460-124553-4	CFSWP-016 460-129850-4	CFSWP-016 460-135182-6	CFSWP-016-DUP 460-135182-7	CFSWP-025 460-125810-2	CFSWP-025 460-129850-3	CFSWP-025 460-135255-3
Sample Lab IDs									
Sample Name Chemical	CFSWP-DUP7-SW 6/13/2017	CFSWP-016-SW 8/29/2016	CFSWP-016-SW 11/30/2016	CFSWP-016-SW 3/13/2017	CFSWP-016-SW 6/12/2017	CFSWP-DUP6-SW 6/12/2017	CFSWP-025-SW 12/20/2016	CFSWP-025-SW 3/13/2017	CFSWP-025-SW 6/13/2017
GENERAL CHEMISTRY ANIONS (µg/L)									

Fluoride	136	58.8 J	123 J-	132	135	137	115 J-	128	134
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

µg/L = microgram(s) per liter

Appendix A-7d
Western Undeveloped Area (sediment)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSDP-014 200-35201-1, 460-	CFSDP-015 200-35201-2, 460-	CFSDP-016 200-35201-3, 460-
Sample Lab IDs	119363-1	119363-2	119363-3
Sample Name Chemical	CFSDP-014-SD 8/29/2016	CFSDP-015-SD 8/29/2016	CFSDP-016-SD 8/29/2016
GENERAL CHEMISTRY ANIONS (mg/kg)			
Fluoride	1.63 J+	1.41 J+	1.71 J+

Footnotes:

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate

mg/kg = milligram(s) per kilogram

Appendix A-8a
South Percolation Pond Area Soil (0-0.5 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-101	CFSB-102	CFSB-104	CFSB-109	CFSB-110	CFSB-113	CFSB-115	CFSB-116	CFSB-118	CFSB-151	CFSB-152	CFSB-153	CFSB-114	CFSB-119	CFSB-142	CFSB-143	CFSB-144	
Sample Lab IDs	460-117506-1 CFSB-101-SO-0-	460-117124-10 CFSB-102-SO-0-	460-117124-7 CFSB-104-SO-0-	460-117124-14 CFSB-109-SO-0-	460-117124-17 CFSB-110-SO-0-	460-119512-1 CFSB-113-SO-0-	460-119512-9 CFSB-115-SO-0-	460-119512-4 CFSB-116-SO-0-	460-117573-1 CFSB-118-SO-0-0.5	460-117506-4 CFSB-151-SO-0-	200-40872-1, 460-144726-8 CFSB-152-SO-0-	200-40872-4, 460-144726-6 CFSB-153-SO-0-	460-144478-14 CFSB-114-SO-0-	460-116987-10 CFSB-119-SO-0-	460-116987-7 CFSB-142-SO-0-	460-144400-5 CFSB-143-SO-0-	460-144400-8 CFSB-144-SO-0-	460-144400-17
Sample Name	0.5	0.5	0.5	0.5	0.5	0.5	0.5Pb	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Sample Depth	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	
Chemical	7/21/2016	7/13/2016	7/13/2016	7/13/2016	7/14/2016	8/31/2016	8/31/2016	7/22/2016	7/21/2016	7/21/2017	11/7/2017	11/6/2017	7/12/2016	7/12/2016	11/2/2017	11/2/2017	11/3/2017	

GENERAL CHEMISTRY (mg/kg)

Fluoride	18.5 J+	7.21 J	12.6 J	17.4 J	28.4 J	2.97 J+	--	2.4 J+	3.81	1.8 J+	18.3 J+	44.1 J+	30.4 J+	3.18 J	4.81 J	22.1 J+	17.1 J+	19.5 J+
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Preliminary - Under EPA and MDEQ Review

Appendix A-8a
South Percolation Pond Area Soil (0-0.5 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-145	CFSB-146	CFSB-147	CFSB-147-DUP	CFSB-148	CFMW-061	CFMW-061	CFMW-064	CFMW-064
Sample Lab IDs	460-144478-1 CFSB-145-SO-0-	460-144478-4 CFSB-146-SO-0-	460-144478-8 CFSB-147-SO-0-	460-144478-7 CFSB-DUP16-SO	460-144478-11 CFSB-148-SO-0-	460-116987-13 CFMW-061-SO-	460-116987-17 CFMW-061-SO-	460-116987-2 CFMW-064-SO-0-	460-116987-6 CFMW-064-SO-0-
Sample Name	0.5	0.5	0.5	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0.5	0.5Pb
Sample Depth	0-0.5 ft	0-0.5 ft	0-0.5 ft	11/6/2017	11/6/2017	11/6/2017	7/12/2016	0-0.5 ft	0-0.5 ft
Chemical	11/6/2017	11/6/2017	11/6/2017					7/11/2016	7/11/2016

GENERAL CHEMISTRY (mg/kg)

Fluoride	14.4 J+	14.7 J+	12.4 J+	10.6 J+	12.3 J+	3.06 J	--	15 J	--
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Attachment A-8b
South Percolation Pond Area Soil (0-2 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-101	CFSB-101	CFSB-102	CFSB-102	CFSB-104	CFSB-104	CFSB-109	CFSB-109	CFSB-110	CFSB-110	CFSB-113	CFSB-113	CFSB-113	CFSB-115	CFSB-115	CFSB-115	CFSB-116	CFSB-116
Sample Lab IDs	460-117506-1	460-117506-2	460-117124-10	460-117124-11	460-117124-7	460-117124-8	460-117124-14	460-117124-15	460-117124-17	460-117124-18	460-119512-1	460-119512-9	460-119512-2	460-119512-4	460-119512-5	460-117573-1	460-117573-2	
Sample Name	CFSB-101-SO-0-	CFSB-101-SO-	CFSB-102-SO-0-	CFSB-102-SO-	CFSB-104-SO-0-0.5	CFSB-104-SO-	CFSB-109-SO-0-	CFSB-109-SO-	CFSB-110-SO-0-	CFSB-110-SO-	CFSB-113-SO-0-	CFSB-113-SO-0-	CFSB-113-SO-0-	CFSB-115-SO-0-	CFSB-115-SO-0-	CFSB-116-SO-0-	CFSB-116-SO-	
Sample Depth	0.5	0.5-2	0.5	0.5	0.5-2	0.5-2	0.5-2	0.5-2	0.5	0.5-2	0.5	0.5Pb	0.5	0.5-2	0.5	0.5-2	0.5-2	
Chemical	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	
GENERAL CHEMISTRY (mg/kg)																		
Fluoride	18.5 J+	10.2 J+	7.21 J	8.74 J	12.6 J	11.4 J	17.4 J	17.7 J	28.4 J	11.2 J	2.97 J+	--	1.26 J+	2.4 J+	1.58 J+	3.81	1.96 J	

Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Attachment A-8b
South Percolation Pond Area Soil (0-2 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-118	CFSB-118	CFSB-151	CFSB-151	CFSB-152	CFSB-152	CFSB-153	CFSB-153	CFSB-114	CFSB-114	CFSB-119	CFSB-119	CFSB-142	CFSB-142	CFSB-143	CFSB-143	CFSB-143-DUP		
Sample Lab IDs	460-117506-4	460-117506-5	200-40872-1, CFSB-118-SO-0	460-144726-8 CFSB-118-SO-	200-40872-2, CFSB-151-SO-0	460-144726-6 CFSB-152-SO-0	200-40872-4, CFSB-152-SO-0	200-40872-5, CFSB-153-SO-0	460-144478-14 CFSB-153-SO-0	460-144478-15 CFSB-114-SO-0	460-116987-10 CFSB-114-SO-0	460-116987-11 CFSB-119-SO-0	460-116987-8 CFSB-119-SO-0	460-116987-7 CFSB-142-SO-0	460-144400-5 CFSB-142-SO-0	460-144400-6 CFSB-143-SO-0	460-144400-8 CFSB-143-SO-0	460-144400-9 CFSB-DUP15-SO	460-144400-11
Sample Name	0.5	0.5-2	0.5	0.5	0.5-2	0.5	0.5-2	0.5	0.5-2	0.5	0.5-2	0.5	0.5-2	0.5	0.5-2	0.5	0.5-2		
Sample Depth	0-0.5 ft	0.5-2 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft		
Chemical	7/21/2016	7/21/2016	11/7/2017	11/7/2017	11/7/2017	11/7/2017	11/6/2017	11/6/2017	11/6/2017	11/6/2017	7/12/2016	7/12/2016	7/12/2016	7/12/2016	11/2/2017	11/2/2017	11/2/2017		
GENERAL CHEMISTRY (mg/kg)																			
Fluoride	1.8 J+	1.85 J+	18.3 J+	12.4 J+	44.1 J+	24.7 J+	30.4 J+	31.4 J+	3.18 J	10.1 J	4.81 J	14.6 J	22.1 J+	17.8 J+	17.1 J+	15.5 J+	14.3 J+		

Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Attachment A-8b South Percolation Pond Area Soil (0-2 ft-bgs) Data Used in Human Health Risk Assessment Columbia Falls Aluminum Facility Columbia Falls, Montana																		
Sample Location ID	CFSB-144	CFSB-144	CFSB-145	CFSB-145	CFSB-146	CFSB-146	CFSB-147	CFSB-147-DUP	CFSB-147	CFSB-148	CFSB-148	CFMW-061	CFMW-061	CFMW-061	CFMW-064	CFMW-064	CFMW-064	
Sample Lab IDs	460-144400-17	460-144400-18	460-144478-1	460-144478-2	460-144478-4	460-144478-5	460-144478-8	460-144478-7	460-144478-9	460-144478-11	460-144478-12	460-116987-13	460-116987-17	460-116987-14	460-116987-2	460-116987-6	460-116987-3	
Sample Name	CFSB-144-SO-0-	CFSB-144-SO-	CFSB-145-SO-0-	CFSB-145-SO-	CFSB-146-SO-0-	CFSB-146-SO-	CFSB-147-SO-0-	CFSB-DUP16-SO	CFSB-147-SO-	CFSB-148-SO-	CFSB-148-SO-0-	CFSB-061-SO-	CFSB-061-SO-	CFSB-061-SO-	CFSB-064-SO-0	CFSB-064-SO-0	CFSB-064-SO-0	
Sample Depth	0.5	0.5-2	0.5	0.5-2	0.5	0.5-2	0.5	0.5-2 ft	0.5	0.5-2	0.5	0-0.5Pb	0-0.5	0.5-2	0.5Pb	0.5-2	0.5-2	
Chemical	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	
GENERAL CHEMISTRY (mg/kg)																		
Fluoride	19.5 J+	18.6 J+	14.4 J+	16.9 J+	14.7 J+	18.9 J+	12.4 J+	10.6 J+	12.4 J+	12.3 J+	18.6 J+	3.06 J	--	4.88 J	15 J	--	15.2 J	

Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-8c
South Percolation Pond Area (surface water)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSWP-018	CFSWP-018	CFSWP-018	CFSWP-018	CFSWP-019	CFSWP-019	CFSWP-019	CFSWP-019	CFSWP-020	CFSWP-020	CFSWP-020	CFSWP-020	CFSWP-020	CFSWP-030	CFSWP-031	CFSWP-032	
Sample Lab IDs	460-114944-1	460-124639-5	460-130874-3	460-135444-1	460-114944-2	460-124639-6	460-130874-4	460-135444-2	460-144576-1	460-114944-3	460-124639-7	460-129875-6	460-135444-3	460-144576-2	460-144395-1	460-144395-2	460-144395-4
Sample Name	CFSWP-018-	CFSWP-018-	CFSWP-018-	CFSWP-018-	CFSWP-019-	CFSWP-019-	CFSWP-019-	CFSWP-019-	CFSWP-020-	CFSWP-020-	CFSWP-020-	CFSWP-020-	CFSWP-020-	CFSWP-030-	CFSWP-031-	CFSWP-032-	
Chemical	6/6/2016	12/1/2016	4/3/2017	6/15/2017	6/6/2016	12/1/2016	4/3/2017	6/15/2017	11/7/2017	6/6/2016	12/1/2016	3/16/2017	6/15/2017	11/7/2017	11/3/2017	11/3/2017	11/3/2017
GENERAL CHEMISTRY (µg/l)																	
Fluoride	353	828 J-	365	1700	379	785 J-	350	305	9240 J-	250	265 J-	330 J	308	418 J-	2580	3420	2720

Footnotes:

- = Result is biased low

J = The analyte was positively identified; the associated numerical value is the

µg/L = microgram(s) per liter

Appendix A-8d
South Percolation Pond Area (sediment)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-149	CFSB-150	CFSDP-018 200-35201-13, 460-119830-3	CFSDP-018 460-144726-3	CFSDP-019 200-35201-14, 460-119830-4	CFSDP-019 460-144726-4	CFSDP-020 200-35201-15, 460-119830-5	CFSDP-020 CFSDP-019-SD 11/7/2017	CFSDP-030 460-144400-13	CFSDP-031 460-144400-14	CFSDP-032 460-144400-15	
Sample Lab IDs	460-144726-2	460-144726-1	CFSB-149-SD-0-0.5 11/7/2017	CFSB-150-SD-0-0.5 11/7/2017	CFSDP-018-SD 9/7/2016	CFSDP-018-SD 11/7/2017	CFSDP-019-SD 9/7/2016	CFSDP-020-SD 9/7/2016	CFSDP-020-SD 11/7/2017	CFSDP-030-SD 11/3/2017	CFSDP-031-SD 11/3/2017	CFSDP-032-SD 11/3/2017
Sample Name												
Chemical												
GENERAL CHEMISTRY (mg/kg)												
Fluoride		19.5 J+	22.6 J+	19.1	74 J+	29.4	93.7 J+	5.3	34.9 J+	20.8 J+	22.2 J+	17.2 J+

Footnotes:

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration

mg/kg = milligram(s) per kilogram

Appendix A-9a Flathead River Area (surface water) Data Used in Human Health Risk Assessment Columbia Falls Aluminum Facility Columbia Falls, Montana																
Sample Location ID	CFSWP-001	CFSWP-001	CFSWP-001	CFSWP-001	CFSWP-001	CFSWP-002	CFSWP-002	CFSWP-002	CFSWP-006	CFSWP-006	CFSWP-006	CFSWP-006	CFSWP-007	CFSWP-007	CFSWP-007	CFSWP-007
Sample Lab IDs	460-120379-1	460-124726-1	460-130969-1	460-135338-1	460-120379-2	460-124726-2	460-135338-2	460-119967-4	460-124639-4	460-129875-4	460-135338-6	460-120379-3	460-124726-3	460-129875-5	460-135338-7	460-135338-7
Sample Name	CFSWP-001-SW	CFSWP-001-SW	CFSWP-001-SW	CFSWP-001-SW	CFSWP-001-SW	CFSWP-002-SW	CFSWP-002-SW	CFSWP-002-SW	CFSWP-006-SW	CFSWP-006-SW	CFSWP-006-SW	CFSWP-007-SW	CFSWP-007-SW	CFSWP-007-SW	CFSWP-007-SW	CFSWP-007-SW
Chemical	9/16/2016	12/2/2016	4/4/2017	6/14/2017	9/16/2016	12/2/2016	4/4/2017	6/14/2017	9/9/2016	12/1/2016	3/16/2017	6/14/2017	9/16/2016	12/2/2016	3/16/2017	6/14/2017
GENERAL CHEMISTRY ANIONS (µg/L)																
Fluoride	35.8 J-	211 J-	84.2	-118	35.9 J-	547 J-	95	119	37.3 J	106 J-	122 J	122	33.8 J-	110 J-	114 J	123

Footnotes:

-- = not applicable

- = Result is biased low

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

µg/L = microgram(s) per liter

Appendix A-9a
Flathead River Area (surface water)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSWP-008 460-120379-4	CFSWP-008 460-124726-4	CFSWP-008 460-130969-3	CFSWP-008 460-135338-8	CFSWP-026 460-144086-4	CFSWP-033 460-144395-3
Sample Lab IDs	CFSWP-008-SW 9/16/2016	CFSWP-008-SW 12/2/2016	CFSWP-008-SW 4/4/2017	CFSWP-008-SW 6/14/2017	CFSWP-026-SW 10/31/2017	CFSWP-033-SW 11/3/2017
Sample Name	Chemical					
GENERAL CHEMISTRY ANIONS (µg/L)						
Fluoride	33.5 J-	107 J-	96.8	124	308	2160

Footnotes:

- = not applicable

- = Result is biased low

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

µg/L = microgram(s) per liter

Appendix A-9b
Flathead River Area (sediment)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSDP-001 200-35201-16,	CFSDP-002 460-119897-2	CFSDP-006 460-119996-4	CFSDP-007 200-35201-17, 460-119897-3	CFSDP-008 200-35201-18, 460-119897-4	CFSDP-026 460-144087-8 CFSDP-026-SD	CFSDP-033 460-144400-16 CFSDP-033-SD
Sample Lab IDs	460-119897-1						
Sample Name	CFSDP-001-SO	CFSDP-002-SO	CFSDP-006-SD	CFSDP-007-SO	CFSDP-008-SO		
Sample Depth	0-0.5 ft	0-0.5 ft	?-? ?	0-0.5 ft	0-0.5 ft	?-? ?	?-? ?
Chemical	9/8/2016	9/8/2016	9/9/2016	9/8/2016	9/8/2016	10/31/2017	11/3/2017
GENERAL CHEMISTRY ANIONS (mg/kg)							
Fluoride	0.78 J	0.36 J	1.23 J+	1.69	0.65 J	69.2 J+	19.2 J+

Footnotes:

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate

mg/kg = milligram(s) per kilogram

Attachment A-10a
Backwater Seep Sampling Area Soil (0-0.5 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-137	CFSB-138	CFSB-140	CFSB-141	CFSB-134	CFSB-135	CFSB-136
Sample Lab IDs	460-144170-9 CFSB-137-SO-0-	460-144170-4 CFSB-138-SO-0-	460-144087-3 CFSB-140-SO-0-	460-144170-7 CFSB-141-SO-0-	460-144087-11 CFSB-134-SO-0-	460-144087-13 CFSB-135-SO-0-	460-144087-15 CFSB-136-SO-0-
Sample Name	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sample Depth	0-0.5 ft	0-0.5 ft	0-0.5 ft				
Chemical	11/1/2017	11/1/2017	10/31/2017	11/1/2017	10/31/2017	10/31/2017	10/31/2017

GENERAL CHEMISTRY (mg/kg)

Fluoride	17 J+	32.7 J+	12.8 J+	16.4 J+	25.7 J+	22.2 J+	14.5 J+
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Footnotes:

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Attachment A-10b
Backwater Seep Sampling Area Soil (0-2 ft-bgs)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSB-137	CFSB-137	CFSB-137	CFSB-138	CFSB-138	CFSB-138-DUP	CFSB-140	CFSB-140	CFSB-141	CFSB-141	CFSB-141	CFSB-134	CFSB-134	CFSB-135	CFSB-135	CFSB-136	CFSB-136	
Sample Lab IDs	460-144170-9	460-144170-10	460-144400-1	460-144170-4	460-144170-5	460-144170-6	460-144087-3	460-144087-4	460-144170-7	460-144170-8	460-144400-4	460-144087-11	460-144087-12	460-144087-13	460-144087-14	460-144087-15	460-144087-16	
Sample Name	CFSB-137-SO-0-	CFSB-137-SO-0.5	CFSB-137-SO-	CFSB-138-SO-0	CFSB-138-SO-0.5	CFSB-140-SO-0-	CFSB-140-SO-0.5	CFSB-141-SO-0	CFSB-141-SO-0.5	CFSB-141-SO-0	CFSB-141-SO-0.5	CFSB-134-SO-0-	CFSB-134-SO-0.5	CFSB-135-SO-0-	CFSB-135-SO-0.5	CFSB-136-SO-0-	CFSB-136-SO-0.5	
Sample Depth	0.5	2	0.5-2	0.5-2 ft	0.5-2 ft	0.5-2 ft	0.5-2 ft	0.5-2 ft	0.5-2 ft	0.5-2 ft	0.5-2 ft	0.5	2	0.5	2	0.5	2	
Chemical	0-0.5 ft	0.5-2 ft	0.5-2 ft	11/2/2017	11/1/2017	11/1/2017	11/1/2017	10/31/2017	10/31/2017	11/1/2017	11/2/2017	10/31/2017	10/31/2017	10/31/2017	10/31/2017	10/31/2017	10/31/2017	10/31/2017

GENERAL CHEMISTRY (mg/kg)

Fluoride	17 J+	16.7 J+	--	32.7 J+	19.3 J	33.5 J	12.8 J+	14.9 J+	16.4 J+	1.58 J+	--	25.7 J+	21.7 J+	22.2 J+	22.9 J+	14.5 J+	15.4 J+
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Footnotes:

-- = not applicable

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Attachment A-10c
Backwater Seep Sampling Area (surface water)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSWP-027	CFSWP-029	CFSWP-003	CFSWP-003	CFSWP-003	CFSWP-003	CFSWP-003	CFSWP-004	CFSWP-004	CFSWP-004	CFSWP-004	CFSWP-004	CFSWP-005	CFSWP-005	CFSWP-005	CFSWP-005	CFSWP-005-DUP	CFSWP-028	
Sample Lab IDs	460-144086-5	460-144175-3	460-119967-1	460-124639-1	460-129875-1	460-135338-3	460-144086-1	460-119967-2	460-124639-2	460-129875-2	460-135338-4	460-144086-2	460-119967-3	460-124639-3	460-129875-3	460-135338-5	460-144175-1	460-144175-2	460-144086-3
Sample Name Chemical	CFSWP-027-SW 10/31/2017	CFSWP-029-SW 11/1/2017	CFSWP-003-SW 9/9/2016	CFSWP-003-SW 12/1/2016	CFSWP-003-SW 3/16/2017	CFSWP-003-SW 6/14/2017	CFSWP-003-SW 10/31/2017	CFSWP-004-SW 9/9/2016	CFSWP-004-SW 12/1/2016	CFSWP-004-SW 3/16/2017	CFSWP-004-SW 6/14/2017	CFSWP-004-SW 10/31/2017	CFSWP-005-SW 9/9/2016	CFSWP-005-SW 12/1/2016	CFSWP-005-SW 3/16/2017	CFSWP-005-SW 6/14/2017	CFSWP-005-SW 11/1/2017	CFSWP-DUP8-SW 11/1/2017	CFSWP-028-SW 10/31/2017
GENERAL CHEMISTRY (µg/l)																			
Fluoride	320	2400 J+	181	615 J-	198 J	192	646	2560	1810 J-	342 J	175	2470	2570	2100 J-	457 J	555	2440 J+	2640 J+	311

Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

J = The analyte was positively identified; the associated

µg/L = microgram(s) per liter

Attachment A-10d
Backwater Seep Sampling Area (sediment)
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFSDP-027	CFSDP-029	CFSDP-003 200-35201-20, 460-119996-1	CFSDP-003 200-35201-21, 460-119996-2	CFSDP-004 200-35201-22, 460-119996-3	CFSDP-004 200-35201-22, 460-119996-3	CFSDP-005 200-35201-22, 460-119996-3	CFSDP-005 200-35201-22, 460-119996-3	CFSDP-005-DUP 460-144170-3	CFSDP-005-DUP 460-144400-2	CFSDP-005 460-144400-3	CFSDP-005-DUP 460-144087-10	CFSDP-028
Sample Lab IDs	460-144087-9	460-144170-1	CFSDP-027-SD 10/31/2017	CFSDP-029-SD 11/1/2017	CFSDP-003-SD 9/9/2016	CFSDP-003-SD 10/31/2017	CFSDP-004-SD 9/9/2016	CFSDP-004-SD 10/31/2017	CFSDP-005-SD 9/9/2016	CFSDP-005-SD 11/1/2017	CFSDP-005-SD 11/1/2017	CFSDP-005-SD 11/2/2017	CFSDP-028-SD 10/31/2017
Sample Name													
Chemical													

GENERAL CHEMISTRY (mg/kg)

Fluoride	21.8 J+	22.2 J+	10.4 J+	24.8 J+	8.57 J+	22.7 J+	13.7 J+	20.5 J+	16.7 J+	--	--	--	22.9 J+
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Footnotes:

-- = not applicable

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration

mg/kg = milligram(s) per kilogram

Appendix A-11a
Groundwater - Plume Area Upper Hydrogeologic Unit
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Site	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological					
Sample Facility	ECO EXP AREA 3 CENTRAL LANDFILLS AREA Upper Hydrogeologic Unit	ECO EXP AREA 3 NORTH-CENTRAL UNDEVELOPED AREA	ECO EXP AREA 6 NORTH-CENTRAL UNDEVELOPED Upper Hydrogeologic Unit	ECO EXP AREA 3 CENTRAL LANDFILLS AREA Upper Hydrogeologic Unit												
Sample Investigation Area	LANDFILLS AREA Upper Hydrogeologic Unit	LANDFILLS AREA Upper Hydrogeologic Unit	LANDFILLS AREA Upper Hydrogeologic Unit	LANDFILLS AREA Upper Hydrogeologic Unit	LANDFILLS AREA Upper Hydrogeologic Unit	LANDFILLS AREA Upper Hydrogeologic Unit	LANDFILLS AREA Upper Hydrogeologic Unit	LANDFILLS AREA Upper Hydrogeologic Unit	LANDFILLS AREA Upper Hydrogeologic Unit	LANDFILLS AREA Upper Hydrogeologic Unit	LANDFILLS AREA Upper Hydrogeologic Unit					
Sample Water Bearing Zone	Upper Hydrogeologic Unit	Upper Hydrogeologic Unit	Upper Hydrogeologic Unit	Upper Hydrogeologic Unit	Upper Hydrogeologic Unit	Upper Hydrogeologic Unit	Upper Hydrogeologic Unit	Upper Hydrogeologic Unit	Upper Hydrogeologic Unit	Upper Hydrogeologic Unit	Upper Hydrogeologic Unit	Upper Hydrogeologic Unit	Upper Hydrogeologic Unit	Upper Hydrogeologic Unit	Upper Hydrogeologic Unit	Upper Hydrogeologic Unit
Sample Location ID	CFMW-002 460-120053-1	CFMW-002 460-130333-4	CFMW-002 460-136178-9	CFMW-010 460-120053-2	CFMW-010 460-125567-2	CFMW-010 460-130333-5	CFMW-010 460-136178-8	CFMW-011 460-120143-13	CFMW-011 460-125105-2	CFMW-011 460-130410-7	CFMW-011 460-136263-7	CFMW-011-DUP 460-136263-11	CFMW-012 460-120053-5	CFMW-012 460-125477-4	CFMW-012 460-130225-3	CFMW-012 460-135989-9
Sample Lab IDs																
Sample Name	CFMW-002-GW 9/12/2016	CFMW-002-GW 3/24/2017	CFMW-002-GW 6/27/2017	CFMW-010-GW 9/12/2016	CFMW-010-GW 12/15/2016	CFMW-010-GW 3/24/2017	CFMW-010-GW 6/27/2017	CFMW-011-GW 9/13/2016	CFMW-011-GW 12/8/2016	CFMW-011-GW 3/27/2017	CFMW-011-GW 6/28/2017	CFMW-012-GW 6/28/2017	CFMW-012-GW 9/12/2016	CFMW-012-GW 12/14/2016	CFMW-012-GW 3/22/2017	CFMW-012-GW 6/23/2017
GENERAL CHEMISTRY ANIONS ($\mu\text{g/L}$)																
Fluoride	18900	8900	4930	30900	3190	17200	5810	207	241 J	298 J+	297 J-	289 J-	12400	5750 J	12600 J+	30600

Footnotes:

- = Result is biased low

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

$\mu\text{g/L}$ = microgram(s) per liter

Appendix A-11a
 Groundwater - Plume Area Upper Hydrogeologic Unit
 Data Used in Human Health Risk Assessment
 Columbia Falls Aluminum Facility
 Columbia Falls, Montana

Sample Site	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological														
Sample Facility	ECO EXP AREA 3 CENTRAL LANDFILLS AREA Upper Hydrogeologic Unit															
Sample Investigation Area	LANDFILLS AREA Upper Hydrogeologic Unit	LANDFILLS AREA Upper Hydrogeologic Unit														
Sample Water Bearing Zone	CFMW-014 460-120053-7	CFMW-014 460-125567-4	CFMW-014 460-130620-1	CFMW-014 460-136178-11	CFMW-015 460-120053-8	CFMW-015 460-125567-3	CFMW-015 460-130620-2	CFMW-015 460-136178-10	CFMW-016 460-130507-5	CFMW-016 460-136351-4	CFMW-016-DUP 460-130507-4	CFMW-016A 460-120664-3	CFMW-016A 460-125477-9	CFMW-016A 460-130410-3	CFMW-016A 460-136063-4	CFMW-016A 460-130507-9
Sample Location ID																
Sample Lab IDs																
Sample Name	CFMW-014-GW 9/12/2016	CFMW-014-GW 12/15/2016	CFMW-014-GW 3/29/2017	CFMW-014-GW 6/27/2017	CFMW-015-GW 9/12/2016	CFMW-015-GW 12/15/2016	CFMW-015-GW 3/29/2017	CFMW-015-GW 6/27/2017	CFMW-016-GW 3/28/2017	CFMW-016-GW 3/28/2017	CFMW-016-GW 6/29/2017	CFMW-016a-GW 9/21/2016	CFMW-016a-GW 12/14/2016	CFMW-016a-GW 3/27/2017	CFMW-016a-GW 6/26/2017	CFMW-017-GW 3/28/2017
GENERAL CHEMISTRY ANIONS (µg/L)																
Fluoride	8300	17300 J-	13000	3960	38400	16800 J-	4740	52900	428	438	338	304	293 J-	358 J+	293 J+	13400

Footnotes:

- = Result is biased low

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

µg/L = microgram(s) per liter

Appendix A-11a
Groundwater - Plume Area Upper Hydrogeologic Unit
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Site	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological													
Sample Facility	ECO EXP AREA 3 CENTRAL LANDFILLS AREA Upper Hydrogeologic Unit	ECO EXP AREA 3 NORTH PERCOLATION POND AREA Upper Hydrogeologic Unit	ECO EXP AREA 2 NORTH PERCOLATION POND AREA Upper Hydrogeologic Unit	ECO EXP AREA 2 NORTH PERCOLATION POND AREA Upper Hydrogeologic Unit													
Sample Investigation Area																	
Sample Water Bearing Zone																	
Sample Location ID	CFMW-017 460-136063-6	CFMW-019 460-120053-3	CFMW-019 460-125567-5	CFMW-019 460-130620-3	CFMW-019 460-136351-5	CFMW-021 460-120053-9	CFMW-021 460-125477-1	CFMW-021 460-130620-4	CFMW-021 460-136063-11	CFMW-022 460-120143-12	CFMW-022 460-125196-7	CFMW-022 460-130507-6	CFMW-022 460-136063-10	CFMW-027 460-120143-11	CFMW-027 460-125477-3	CFMW-027 460-130410-6	CFMW-027 460-130410-6
Sample Name	CFMW-017-GW 6/26/2017	CFMW-019-GW 9/12/2016	CFMW-019-GW 12/15/2016	CFMW-019-GW 3/29/2017	CFMW-019-GW 6/29/2017	CFMW-021-GW 9/12/2016	CFMW-021-GW 12/14/2016	CFMW-021-GW 3/29/2017	CFMW-021-GW 6/26/2017	CFMW-022-GW 9/13/2016	CFMW-022-GW 12/9/2016	CFMW-022-GW 3/28/2017	CFMW-022-GW 6/26/2017	CFMW-027-GW 9/13/2016	CFMW-027-GW 12/14/2016	CFMW-027-GW 3/27/2017	
GENERAL CHEMISTRY ANIONS (µg/L)																	
Fluoride	1160 J+	2860	2890	2950	3720	1950	3120 J-	4500	1930 J+	432	558 J-	971	573 J+	2390	1970 J-	2560 J+	

Footnotes:

- = Result is biased low

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

µg/L = microgram(s) per liter

Appendix A-11a
Groundwater - Plume Area Upper Hydrogeologic Unit
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Site Sample Facility	Columbia Falls Aluminum Company Site CFAC Ecological ECO EXP AREA 2 NORTH PERCOLATION POND AREA Upper Hydrogeologic Unit	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological	Columbia Falls Aluminum Company Site CFAC Ecological						
Sample Investigation Area	ECO EXP AREA 1 MAIN PLANT AREA Upper Hydrogeologic Unit	ECO EXP AREA 1 MAIN PLANT AREA Upper Hydrogeologic Unit	ECO EXP AREA 1 MAIN PLANT AREA Upper Hydrogeologic Unit	ECO EXP AREA 1 MAIN PLANT AREA Upper Hydrogeologic Unit	ECO EXP AREA 1 MAIN PLANT AREA Upper Hydrogeologic Unit	ECO EXP AREA 1 MAIN PLANT AREA Upper Hydrogeologic Unit	ECO EXP AREA 1 MAIN PLANT AREA Upper Hydrogeologic Unit	ECO EXP AREA 1 MAIN PLANT AREA Upper Hydrogeologic Unit	ECO EXP AREA 3 CENTRAL LANDFILLS AREA	ECO EXP AREA 1 MAIN PLANT AREA	ECO EXP AREA 1 MAIN PLANT AREA	ECO EXP AREA 1 MAIN PLANT AREA					
Sample Water Bearing Zone																	
Sample Location ID	CFMW-027 460-136063-9	CFMW-028 460-120143-10	CFMW-028 460-124783-2	CFMW-028 460-130032-7	CFMW-028 460-136063-7	CFMW-028A 460-120581-8	CFMW-028A 460-130088-11	CFMW-028A 460-125196-5	CFMW-028A 460-136178-4	CFMW-029 460-120143-8	CFMW-029-DUP 460-125477-2	CFMW-029 460-130333-6	CFMW-029 460-136063-8	CFMW-029 460-120318-2	CFMW-031 460-125196-4	CFMW-031 460-12031	CFMW-031 460-125196-4
Sample Name Chemical	CFMW-027-GW 6/26/2017	CFMW-028-GW 9/13/2016	CFMW-028-GW 12/5/2016	CFMW-028-GW 3/20/2017	CFMW-028a-GW 6/26/2017	CFMW-028a-GW 9/20/2016	CFMW-028a-GW 12/9/2016	CFMW-028a-GW 3/21/2017	CFMW-028a-GW 6/27/2017	CFMW-029-GW 9/13/2016	CFMW-029-GW 12/14/2016	CFMW-029-GW 3/24/2017	CFMW-029-GW 6/26/2017	CFMW-031-GW 9/15/2016	CFMW-031-GW 12/9/2016		
GENERAL CHEMISTRY ANIONS ($\mu\text{g/L}$)																	
Fluoride	5190	3170 J+	3130 J-	4400	3800 J+	1020	557 J-	408	286	3370 J+	3370 J+	4180 J	1810 J+	2570 J+	2440	2100 J-	

Footnotes:

- = Result is biased low

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

$\mu\text{g/L}$ = microgram(s) per liter

Appendix A-11a
 Groundwater - Plume Area Upper Hydrogeologic Unit
 Data Used in Human Health Risk Assessment
 Columbia Falls Aluminum Facility
 Columbia Falls, Montana

Sample Site	Columbia Falls Aluminum Company Site CFAC Ecological																	
Sample Facility	ECO EXP AREA 1 MAIN PLANT AREA Upper Hydrogeologic Unit																	
Sample Investigation Area	ECO EXP AREA 1 MAIN PLANT AREA Upper Hydrogeologic Unit																	
Sample Water Bearing Zone																		
Sample Location ID	CFMW-031 460-130088-6	CFMW-031 460-135818-7	CFMW-031-DUP 460-135818-8	CFMW-032 460-120318-1	CFMW-032 460-125356-1	CFMW-032 460-130410-8	CFMW-032 460-135701-7	CFMW-032-DUP 460-124871-1	CFMW-033 460-120318-3	CFMW-033 460-124871-1	CFMW-033 460-130088-3	CFMW-033 460-135619-2	CFMW-034 460-120223-1	CFMW-034 460-125356-2	CFMW-034 460-130088-5	CFMW-034 460-135619-4		
Sample Lab IDs																		
Sample Name	CFMW-031-GW 3/21/2017	CFMW-031-GW 6/21/2017	GW	CFMW-032-GW 6/21/2017	CFMW-032-GW 9/15/2016	CFMW-032-GW 12/13/2016	CFMW-032-GW 3/27/2017	CFMW-032-GW 6/20/2017	CFMW-033-GW 6/20/2017	CFMW-033-GW 9/15/2016	CFMW-033-GW 12/6/2016	CFMW-033-GW 3/21/2017	CFMW-034-GW 6/19/2017	CFMW-034-GW 9/14/2016	CFMW-034-GW 12/13/2016	CFMW-034-GW 3/21/2017	CFMW-034-GW 6/19/2017	
GENERAL CHEMISTRY ANIONS ($\mu\text{g/L}$)																		
Fluoride	2700	2770 J-	2800 J-	5210 J-	2490	3060 J+	8570	8460	2340	2040 J-	2620	3250	4530 J-	60 U	3200	6590		

Footnotes:

- = Result is biased low

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

$\mu\text{g/L}$ = microgram(s) per liter

Appendix A-11a
 Groundwater - Plume Area Upper Hydrogeologic Unit
 Data Used in Human Health Risk Assessment
 Columbia Falls Aluminum Facility
 Columbia Falls, Montana

Sample Site	Columbia Falls Aluminum Company Site CFAC Ecological																
Sample Facility	ECO EXP AREA 1 MAIN PLANT AREA Upper Hydrogeologic Unit																
Sample Investigation Area	ECO EXP AREA 1 MAIN PLANT AREA Upper Hydrogeologic Unit																
Sample Water Bearing Zone																	
Sample Location ID	CFMW-038 460-120223-10	CFMW-038 460-125196-8	CFMW-038 460-130333-7	CFMW-038 460-136178-6	CFMW-040 460-120223-11	CFMW-040 460-125356-4	CFMW-040 460-130691-3	CFMW-040 460-135701-10	CFMW-042 460-120223-3	CFMW-042 460-120143-8	CFMW-043 460-125477-5	CFMW-043 460-130032-8	CFMW-043 460-135818-9	CFMW-043 460-120318-4	CFMW-044 460-125196-2		
Sample Lab IDs																	
Sample Name	CFMW-038-GW 9/14/2016	CFMW-038-GW 12/9/2016	CFMW-038-GW 3/24/2017	CFMW-038-GW 6/27/2017	CFMW-040-GW 9/14/2016	CFMW-040-GW 12/13/2016	CFMW-040-GW 3/30/2017	CFMW-040-GW 6/20/2017	CFMW-042-GW 9/14/2016	CFMW-042-GW 9/13/2016	CFMW-043-GW 6/20/2017	CFMW-043-GW 12/14/2016	CFMW-043-GW 3/20/2017	CFMW-043-GW 6/21/2017	CFMW-044-GW 9/15/2016	CFMW-044-GW 12/9/2016	
GENERAL CHEMISTRY ANIONS (µg/L)																	
Fluoride	2590	2400 J-	2830 J+	2810	2650	2360	3090	2830	2410	2780	2280	2050 J-	2730	2020 J-	2150	1670 J-	

Footnotes:

- = Result is biased low

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

µg/L = microgram(s) per liter

Appendix A-11a
 Groundwater - Plume Area Upper Hydrogeologic Unit
 Data Used in Human Health Risk Assessment
 Columbia Falls Aluminum Facility
 Columbia Falls, Montana

Sample Site	Columbia Falls Aluminum Company Site CFAC Ecological																
Sample Facility	ECO EXP AREA 1 MAIN PLANT AREA Upper Hydrogeologic Unit																
Sample Investigation Area	ECO EXP AREA 1 MAIN PLANT AREA Upper Hydrogeologic Unit																
Sample Water Bearing Zone																	
Sample Location ID	CFMW-044 460-130507-2	CFMW-044 460-135818-10	CFMW-044A 460-120477-7	CFMW-044A 460-125747-3	CFMW-044A 460-130088-13	CFMW-044A 460-135989-3	CFMW-045 460-120318-5	CFMW-045 460-125477-11	CFMW-045 460-130226-7	CFMW-045 460-136263-8	CFMW-045A 460-120477-2	CFMW-045A 460-125196-9	CFMW-045A 460-130333-8	CFMW-045A 460-135989-5	CFMW-047 460-120223-7	CFMW-047 460-125567-10	
Sample Name	CFMW-044-GW 3/28/2017	CFMW-044-GW 6/21/2017	CFMW-044a-GW 9/19/2016	CFMW-044a-GW 12/19/2016	CFMW-044a-GW 3/21/2017	CFMW-045-GW 6/23/2017	CFMW-045-GW 9/15/2016	CFMW-045-GW 12/14/2016	CFMW-045-GW 3/23/2017	CFMW-045a-GW 6/28/2017	CFMW-045a-GW 9/19/2016	CFMW-045a-GW 12/9/2016	CFMW-045a-GW 3/24/2017	CFMW-047-GW 6/23/2017	CFMW-047-GW 9/14/2016	CFMW-047-GW 12/15/2016	
GENERAL CHEMISTRY ANIONS (µg/L)																	
Fluoride	2050	1400 J-	1720	2280	2720	2250 J+	2300	1920 J-	2550	2150 J-	2980	1650 J-	3520 J+	3400 J+	2160	1960	

Footnotes:

- = Result is biased low

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

µg/L = microgram(s) per liter

Appendix A-11a
Groundwater - Plume Area Upper Hydrogeologic Unit
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Site Sample Facility	Columbia Falls Aluminum Company Site CFAC Ecological								
Sample Investigation Area	ECO EXP AREA 1 MAIN PLANT								
Sample Water Bearing Zone	Upper Hydrogeologic Unit								
Sample Location ID	CFMW-047 460-130226-5	CFMW-047 460-135818-6	CFMW-053 460-120223-5	CFMW-053 460-125342-3	CFMW-053 460-136263-10	CFMW-054 460-120223-6	CFMW-054 460-125342-4	CFMW-054 460-130225-5	CFMW-054 460-135818-12
Sample Name Chemical	CFMW-047-GW 3/23/2017	CFMW-047-GW 6/21/2017	CFMW-053-GW 9/14/2016	CFMW-053-GW 12/12/2016	CFMW-053-GW 6/28/2017	CFMW-054-GW 9/14/2016	CFMW-054-GW 12/12/2016	CFMW-054-GW 3/22/2017	CFMW-054-GW 6/21/2017
GENERAL CHEMISTRY ANIONS (µg/L)									
Fluoride	2470	1920	1990	1870	1610 J-	1920	1610	2070	1880

Footnotes:

- = Result is biased low

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

µg/L = microgram(s) per liter

Appendix A-11b
Groundwater - Western Undeveloped Area Upper Hydrogeologic Unit
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Site	Columbia Falls Aluminum Company Site CFAC Ecological ECO EXP AREA 7 WESTERN UNDEVELOPED								
Sample Facility									
Sample Investigation Area	AREA Upper Hydrogeologic Unit								
Sample Water Bearing Zone	CFMW-056B 460-120143-5	CFMW-056B 460-125342-2	CFMW-056B 460-130088-1	CFMW-056B-DUP 460-130088-2	CFMW-056B 460-135884-10	CFMW-056B 460-120318-8	CFMW-059 460-125342-1	CFMW-059 460-130226-10	CFMW-059 460-135818-11
Sample Location ID	CFMW-056b-GW 9/13/2016	CFMW-056b-GW 12/12/2016	CFMW-056-GW 3/21/2017	CFMW-Dup7-GW 3/21/2017	CFMW-056b-GW 6/22/2017	CFMW-059-GW 9/15/2016	CFMW-059-GW 12/12/2016	CFMW-059-GW 3/23/2017	CFMW-059-GW 6/21/2017

GENERAL CHEMISTRY | ANIONS (µg/L)

Fluoride	156	194	271	266	188	59.5 J	114	120	124
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Footnotes:

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

µg/L = microgram(s) per liter

Appendix A-11c
Groundwater - Sitewide Below Upper Hydrogeologic Unit
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Site Sample Facility	Columbia Falls Alumnum Company Site CFAC Ecological ECO EXP AREA 6 NORTH-CENTRAL UNDEVELOPED AREA	Columbia Falls Alumnum Company Site CFAC Ecological ECO EXP AREA 3 CENTRAL LANDFILLS AREA	Columbia Falls Alumnum Company Site CFAC Ecological ECO EXP AREA 3 CENTRAL LANDFILLS AREA	Columbia Falls Alumnum Company Site CFAC Ecological ECO EXP AREA 3 CENTRAL LANDFILLS AREA	Columbia Falls Alumnum Company Site CFAC Ecological ECO EXP AREA 3 CENTRAL LANDFILLS AREA	Columbia Falls Alumnum Company Site CFAC Ecological ECO EXP AREA 3 CENTRAL LANDFILLS AREA	Columbia Falls Alumnum Company Site CFAC Ecological ECO EXP AREA 3 CENTRAL LANDFILLS AREA									
Sample Investigation Area	Below Upper Hydrogeologic Unit	Below Upper Hydrogeologic Unit	Below Upper Hydrogeologic Unit	Below Upper Hydrogeologic Unit	Below Upper Hydrogeologic Unit	Below Upper Hydrogeologic Unit	Below Upper Hydrogeologic Unit									
Sample Water Bearing Zone																
Sample Location ID Sample Lab IDs	CFMW-003A 460-120581-1	CFMW-003A 460-125342-7	CFMW-003A 460-130032-3	CFMW-003A 460-135619-3	CFMW-011A 460-120581-2	CFMW-011A 460-125477-8	CFMW-011A 460-130088-12	CFMW-011A 460-136351-3	CFMW-012A 460-120318-7	CFMW-012A-DUP 460-120318-12	CFMW-012A 460-125356-7	CFMW-012A 460-130032-1	CFMW-012A 460-135701-3	CFMW-019A 460-120581-3	CFMW-019A 460-125477-10	CFMW-019A 460-130410-2
Sample Name Chemical	CFMW-003a-GW 9/20/2016	CFMW-003a-GW 12/12/2016	CFMW-003a-GW 3/20/2017	CFMW-003a-GW 6/19/2017	CFMW-011a-GW 6/19/2016	CFMW-011a-GW 12/14/2016	CFMW-011a-GW 3/21/2017	CFMW-011a-GW 6/29/2017	CFMW-012a-GW 9/15/2016	CFMW-DUP2-GW 9/15/2016	CFMW-012a-GW 12/13/2016	CFMW-012a-GW 3/20/2017	CFMW-012a-GW 6/20/2017	CFMW-019a-GW 9/20/2016	CFMW-019a-GW 12/14/2016	CFMW-019a-GW 3/27/2017

GENERAL CHEMISTRY ANIONS (µg/L)

Fluoride	312	337	373	276	200	194 J-	246	197	54.6 J	55.8 J	119	135	139	361	182 J-	214 J+
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit. The associated value is the quantitation limit or the estimated detection limit for dioxins or PCB congeners.

µg/L = microgram(s) per liter

Appendix A-11c
Groundwater - Sitewide Below Upper Hydrogeologic Unit
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Site Sample Facility	Columbia Falls Aluminum Company Site CFAC Ecological															
Sample Investigation Area	ECO EXP AREA 3 CENTRAL LANDFILLS AREA	ECO EXP AREA 3 CENTRAL LANDFILLS AREA	ECO EXP AREA 3 CENTRAL LANDFILLS AREA	ECO EXP AREA 7 WESTERN UNDEVELOPED AREA	ECO EXP AREA 7 WESTERN UNDEVELOPED AREA	ECO EXP AREA 7 WESTERN UNDEVELOPED AREA	ECO EXP AREA 1 MAIN PLANT									
Sample Water Bearing Zone	Below Upper Hydrogeologic Unit															
Sample Location ID Sample Lab IDs	CFMW-019A-DUP 460-130410-5	CFMW-019A 460-136063-3	CFMW-025A 460-120143-1	CFMW-025A 460-124783-5	CFMW-025A 460-130333-2	CFMW-025A 460-135884-7	CFMW-032A 460-120382-3	CFMW-032A 460-125644-3	CFMW-032A 460-130620-6	CFMW-032A 460-136178-5	CFMW-044B 460-120477-8	CFMW-044B 460-125747-2	CFMW-044B 460-130333-9	CFMW-044B 460-125989-4	CFMW-053A 460-120477-1	CFMW-053A 460-125747-5
Sample Name Chemical	CFMW-DUP9-GW 3/27/2017	CFMW-019a-GW 6/26/2017	CFMW-025a-GW 9/13/2016	CFMW-025a-GW 12/5/2016	CFMW-025a-GW 3/24/2017	CFMW-025a-GW 6/22/2017	CFMW-032a-GW 9/16/2016	CFMW-032a-GW 12/16/2016	CFMW-032a-GW 3/29/2017	CFMW-044b-GW 6/27/2017	CFMW-044b-GW 9/19/2016	CFMW-044b-GW 12/19/2016	CFMW-044b-GW 3/24/2017	CFMW-044b-GW 6/23/2017	CFMW-053a-GW 9/19/2016	CFMW-053a-GW 12/19/2016

GENERAL CHEMISTRY ANIONS (µg/L)

Fluoride	201 J+	179 J+	399	334 J-	524	413	49 J-	225 J	171	241	153	142	176	138 J+	15 U	537
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit. The associated value is the quantitation limit or the estimated detection limit for dioxins or PCB congeners.

µg/L = microgram(s) per liter

Appendix A-11c
Groundwater - Sitewide Below Upper Hydrogeologic Unit
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Site Sample Facility	Columbia Falls Aluminum Company Site CFAC Ecological																
Sample Investigation Area	ECO EXP AREA 1 MAIN PLANT AREA	ECO EXP AREA 1 MAIN PLANT AREA	ECO EXP AREA 1 WESTERN UNDEVELOPED AREA	ECO EXP AREA 7 WESTERN UNDEVELOPED AREA													
Sample Water Bearing Zone	Below Upper Hydrogeologic Unit																
Sample Location ID Sample Lab IDs	CFMW-053A 460-130410-4	CFMW-053A 460-136263-6	CFMW-056 460-120581-6	CFMW-056-DUP 460-120581-7	CFMW-056 460-125356-8	CFMW-056 460-120225-11	CFMW-056 460-135884-5	CFMW-056A 460-120581-4	CFMW-056A 460-124871-2	CFMW-056A-DUP 460-124871-4	CFMW-056A 460-130691-2	CFMW-056A 460-135884-6	CFMW-057 460-120477-9	CFMW-057 460-124783-6	CFMW-057 460-130620-7	CFMW-057-DUP 460-130620-10	CFMW-DUP11- GW 3/29/2017
Sample Name Chemical	CFMW-053a-GW 3/27/2017	CFMW-053a-GW 6/28/2017	CFMW-056-GW 9/20/2016	CFMW-DUP3-GW 9/20/2016	CFMW-056-GW 12/13/2016	CFMW-056-GW 3/22/2017	CFMW-056-GW 6/22/2017	CFMW-056a-GW 9/20/2016	CFMW-056a-GW 12/6/2016	CFMW-DUP4-GW 12/6/2016	CFMW-056a-GW 3/30/2017	CFMW-056a-GW 6/22/2017	CFMW-057-GW 9/19/2016	CFMW-057-GW 12/5/2016	CFMW-057-GW 3/29/2017	CFMW-057-GW 3/29/2017	

GENERAL CHEMISTRY ANIONS (µg/L)

Fluoride	428 J+	487 J-	138	131	107	242	194	405	400 J-	394 J-	258	569	66.6 J	127 J-	137	136
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit. The associated value is the quantitation limit or the estimated detection limit for dioxins or PCB congeners.

µg/L = microgram(s) per liter

Appendix A-11c
Groundwater - Sitewide Below Upper Hydrogeologic Unit
Data Used in Human Health Risk Assessment
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Site Sample Facility	Columbia Falls Aluminum Company Site CFAC Ecological ECO EXP AREA 7 WESTERN UNDEVELOPED AREA								
Sample Investigation Area	Below Upper Hydrogeologic Unit								
Sample Water Bearing Zone	CFMW-057 460-136263-3	CFMW-057A 460-120477-10	CFMW-057A 460-125644-7	CFMW-057A 460-130225-7	CFMW-057A 460-136263-4	CFMW-059A 460-120477-6	CFMW-059A 460-125644-2	CFMW-059A 460-130620-8	CFMW-059A 460-136263-5
Sample Name Chemical	CFMW-057-GW 6/28/2017	CFMW-057a-GW 9/19/2016	CFMW-057a-GW 12/16/2016	CFMW-057a-GW 3/22/2017	CFMW-057a-GW 6/28/2017	CFMW-059a-GW 9/19/2016	CFMW-059a-GW 12/16/2016	CFMW-059a-GW 3/29/2017	CFMW-059a-GW 6/28/2017
GENERAL CHEMISTRY ANIONS (µg/L)									
Fluoride	204 J-	15 U	180 J	425	322 J-	147	198 J-	233	185 J-

Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit. The associated value is the quantitation limit or the estimated detection limit for dioxins or PCB congeners

µg/L = microgram(s) per liter

Appendix A-12a
Main Plant ISS Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFIIS-024	CFIIS-025	CFIIS-026	CFIIS-027	CFIIS-027-	CFIIS-028	CFIIS-029	CFIIS-030	CFIIS-031	CFIIS-032	CFIIS-033	CFIIS-034	CFIIS-035	CFIIS-036	CFIIS-037	CFIIS-038	CFIIS-039	CFIIS-040	CFIIS-041	CFIIS-042	CFIIS-043
Sample Lab IDs	240-66695-2	240-66695-5	240-66695-7	240-66695-9	240-66695-10	240-66695-12	240-66588-5	240-67693-1	240-67287-1	240-67138-5	240-67138-7	240-67138-1	240-67138-3	240-67353-1	240-67353-3	240-67287-5	240-67287-7	240-67287-3	240-67353-6	240-67463-3	240-67463-1
Sample Name	CFIIS-024-SO-	CFIIS-025-SO-	CFIIS-026-SO-	CFIIS-027-SO-	CFIIS-DUP3-	CFIIS-028-SO-	CFIIS-029-SO-	CFIIS-030-SO-	CFIIS-031-SO-	CFIIS-032-SO-	CFIIS-033-SO-	CFIIS-034-SO-	CFIIS-035-SO-	CFIIS-036-SO-	CFIIS-037-SO-	CFIIS-038-SO-	CFIIS-039-SO-	CFIIS-040-SO-	CFIIS-41-SO-0-	CFIIS-042-SO-	CFIIS-043-SO-
Sample Depth	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	0-0.5	
Chemical	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	
GENERAL CHEMISTRY ANIONS (mg/kg)																					
Fluoride	592 J+	69.8	617 J+	244 J+	239 J+	183 J+	39.9 J	270 J-	391	59.3	544	301	92.8	56.3	83.4	507	60.9	349	84.3	632	534

Footnotes:

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-12b
Central Landfill ISS Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFIIS-001 460-115528-29	CFIIS-002 460-115528-32	CFIIS-002 240-67463-7	CFIIS-003 CFIIS-002-SO-0	CFIIS-004 460-115648-6	CFIIS-004 460-115648-8	CFIIS-005 460-115648-12	CFIIS-006 460-115731-13	CFIIS-006-DUP 460-115731-17	CFIIS-006 240-67463-5	CFIIS-006-DUP 240-67463-9	CFIIS-007 460-115731-15	CFIIS-008 460-115731-18	CFIIS-008 240-67693-3	CFIIS-009 460-116014-3	CFIIS-010 460-116014-5	CFIIS-011 460-115886-15	CFIIS-011 CFIIS-011-SO-0	CFIIS-012 460-115886-18
Sample Lab IDs	CFIIS-001-SO-0 0.5 0-0.5 ft 6/14/2016	CFIIS-002-SO-0 0.5 0-0.5 ft 6/14/2016	CFIIS-003-SO-0 0.5 0-0.5 ft 7/19/2016	CFIIS-004-SO-0 0.5 0-0.5 ft 6/15/2016	CFIIS-005-SO-0 0.5 0-0.5 ft 6/15/2016	CFIIS-006-SO-0 0.5 0-0.5 ft 6/16/2016	CFIIS-006-SO-0 0.5 0-0.5 ft 6/17/2016	CFIIS-DUP1-SO 0-0.5 ft 6/17/2016	CFIIS-DUP1-SO 0-0.5 ft 7/19/2016	CFIIS-DUP1-SO 0-0.5 ft 7/19/2016	CFIIS-007-SO-0 0.5 0-0.5 ft 6/17/2016	CFIIS-008-SO-0 0.5 0-0.5 ft 6/18/2016	CFIIS-008-SO-0 0.5 0-0.5 ft 7/26/2016	CFIIS-009-SO-0 0.5 0-0.5 ft 6/22/2016	CFIIS-010-SO-0 0.5 0-0.5 ft 6/22/2016	CFIIS-011-SO-0 0.5 0-0.5 ft 6/21/2016	CFIIS-012-SO-0 0.5 0-0.5 ft 6/21/2016		
Sample Name																			
Sample Depth																			
Chemical																			
GENERAL CHEMISTRY ANIONS (mg/kg)																			
Fluoride	10.4 J	18.6 J	976	680 J-	86.7 J-	54.9 J-	59	78.1 J-	70.2	73.2	189 J-	328 J-	662 J-	21.8 J+	33.8 J+	41.2 J	45.5 J		

Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-12b
Central Landfill ISS Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFIIS-013 460-115886-6	CFIIS-014 460-115886-8	CFIIS-015 460-115731-20	CFIIS-016 240-66446-1	CFIIS-017 240-66695-1	CFIIS-018 240-66516-1	CFIIS-019 240-66516-3	CFIIS-020 240-66516-5	CFIIS-020- 240-66516-6	CFIIS-021 240-66516-8	CFIIS-022 240-66588-1	CFIIS-023 240-66588-3	CFIIS-024 240-66695-2	CFIIS-025 240-66695-5	CFIIS-026 240-66695-7	CFIIS-027 240-66695-9	CFIIS-027-DUP 240-66695-10	CFIIS-028 240-66695-12	CFIIS-029 240-66588-5
Sample Lab IDs	CFIIS-013-SO-0 460-115886-6	CFIIS-014-SO-0 460-115886-8	CFIIS-015-SO-0 460-115731-20	CFIIS-016-SO-0 240-66446-1	CFIIS-017-SO-0 240-66695-1	CFIIS-018-SO-0 240-66516-1	CFIIS-019-SO-0 240-66516-3	CFIIS-020-SO-0 240-66516-5	CFIIS-020-SO-0 240-66516-6	CFIIS-021-SO-0 240-66516-8	CFIIS-022-SO-0 240-66588-1	CFIIS-023-SO-0 240-66588-3	CFIIS-024-SO-0 240-66695-2	CFIIS-025-SO-0 240-66695-5	CFIIS-026-SO-0 240-66695-7	CFIIS-027-SO-0 240-66695-9	CFIIS-027-DUP-SO-0 240-66695-10	CFIIS-028-SO-0 240-66695-12	CFIIS-029-SO-0 240-66588-5
Sample Name	0.5	0.5	0.5	0.5	0-0.5	0.5	0.5	0.5	0.5	SO	0.5	0-0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Sample Depth	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	0-0.5 ft	
Chemical	6/20/2016	6/20/2016	6/18/2016	6/23/2016	6/29/2016	6/24/2016	6/24/2016	6/25/2016	6/25/2016	6/25/2016	6/27/2016	6/27/2016	6/29/2016	6/30/2016	6/30/2016	7/1/2016	7/1/2016	7/1/2016	
GENERAL CHEMISTRY ANIONS (mg/kg)																			
Fluoride	254 J	318 J	372 J-	27.6	36.7	72.9 J-	215 J-	61.2 J-	60.4 J-	251 J-	732 J+	39.3 J	592 J+	69.8	617 J+	244 J+	239 J+	183 J+	39.9 J

Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-12c
 Central Landfill ISS Area Soil (0-2 ft-bgs)
 Columbia Falls Aluminum Facility
 Columbia Falls, Montana

Sample Location ID	CFIIS-001	CFIIS-001	CFIIS-002	CFIIS-002	CFIIS-002	CFIIS-002	CFIIS-003	CFIIS-004	CFIIS-004	CFIIS-005	CFIIS-005	CFIIS-006	CFIIS-006-DUP	CFIIS-006	CFIIS-006-DUP	CFIIS-006	CFIIS-006-DUP	CFIIS-006	CFIIS-007
Sample Lab IDs	460-115528-29	460-115528-30	460-115528-32	460-115528-33	240-67463-7	240-67463-8	460-115648-6	460-115648-7	460-115648-8	460-115648-9	460-115648-12	460-115648-13	460-115731-13	460-115731-17	460-115731-14	240-67463-5	240-67463-9	240-67463-6	460-115731-15
Sample Name	CFIIS-001-SO-0	CFIIS-001-SO-	CFIIS-002-SO-0	CFIIS-002-SO-	CFIIS-002-SO-	CFIIS-002-SO-	CFIIS-003-SO-	CFIIS-004-SO-0	CFIIS-004-SO-	CFIIS-005-SO-0	CFIIS-005-SO-	CFIIS-006-SO-0	CFIIS-006-SO-	CFIIS-006-SO-	CFIIS-006-SO-	CFIIS-006-SO-	CFIIS-006-SO-	CFIIS-007-SO-0	
Sample Depth	0.5	0.5-2	0.5	0.5-2	0.5-2	0.5-2	0-0.5	0-0.5	0.5-2	0.5-2	0.5-2	0.5-2	0.5-2	0-0.5	0-0.5	0.5-2	0.5-2	0.5	
Chemical	6/14/2016	6/14/2016	6/14/2016	6/14/2016	7/19/2016	7/19/2016	6/15/2016	6/15/2016	6/15/2016	6/15/2016	6/16/2016	6/16/2016	6/17/2016	6/17/2016	6/17/2016	7/19/2016	7/19/2016	6/17/2016	

GENERAL CHEMISTRY | ANIONS (mg/kg)

Fluoride	10.4 J	35.5 J	18.6 J	53.3 J	976	647	680 J-	270 J-	86.7 J-	81.4 J-	54.9 J-	61.8 J-	59	78.1 J-	76 J-	70.2	73.2	85.4	189 J-
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-12c
Central Landfill ISS Area Soil (0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFIIS-007	CFIIS-008	CFIIS-008	CFIIS-008	CFIIS-008	CFIIS-008	CFIIS-009	CFIIS-009	CFIIS-010	CFIIS-010	CFIIS-011	CFIIS-011	CFIIS-012	CFIIS-012	CFIIS-013	CFIIS-013	CFIIS-014	CFIIS-014	CFIIS-015	CFIIS-015
Sample Lab IDs	460-115731-16	460-115731-18	460-115731-19	240-67693-3	240-67693-4	460-116014-3	460-116014-4	460-116014-5	460-116014-6	460-115886-15	460-115886-16	460-115886-18	460-115886-19	460-115886-6	460-115886-7	460-115886-8	460-115886-9	460-115731-20	460-115731-21	
Sample Name	CFIIS-007-SO-	CFIIS-008-SO-0	CFIIS-008-SO-	CFIIS-008-SO-	CFIIS-008-SO-	CFIIS-009-SO-	CFIIS-009-SO-	CFIIS-010-SO-	CFIIS-010-SO-	CFIIS-011-SO-0	CFIIS-011-SO-	CFIIS-012-SO-0	CFIIS-012-SO-	CFIIS-013-SO-0	CFIIS-013-SO-	CFIIS-014-SO-0	CFIIS-014-SO-	CFIIS-015-SO-0	CFIIS-015-SO-	
Sample Depth	0.5-2	0.5	0.5-2	0.5-2 ft	0.5-2 ft	0-0.5	0.5-2	0.5-2 ft	0-0.5 ft	0.5-2 ft	0.5-2 ft	0.5-2 ft								
Chemical	6/17/2016	6/18/2016	6/18/2016	6/18/2016	7/26/2016	7/26/2016	6/22/2016	6/22/2016	6/22/2016	6/22/2016	6/21/2016	6/21/2016	6/21/2016	6/21/2016	6/20/2016	6/20/2016	6/20/2016	6/18/2016	6/18/2016	

GENERAL CHEMISTRY | ANIONS (mg/kg)

Fluoride	141 J-	328 J-	320 J-	662 J-	508 J-	21.8 J+	53.8 J+	33.8 J+	28.3 J+	41.2 J	50.9 J	45.5 J	52.9 J	254 J	337 J	318 J	598 J	372 J-	379 J-
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Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-12c
Central Landfill ISS Area Soil (0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFIIS-016	CFIIS-016	CFIIS-017	CFIIS-017	CFIIS-018	CFIIS-018	CFIIS-019	CFIIS-019	CFIIS-020	CFIIS-020-DUP	CFIIS-020	CFIIS-021	CFIIS-021	CFIIS-022	CFIIS-022	CFIIS-023	CFIIS-023	CFIIS-024	CFIIS-024	CFIIS-024
Sample Lab IDs	240-66446-1	240-66588-7	240-66446-4	240-66695-1	240-66516-1	240-66516-2	240-66516-3	240-66516-4	240-66516-5	240-66516-6	240-66516-7	240-66516-8	240-66516-10	240-66588-1	240-66588-2	240-66588-3	240-66588-4	240-66695-2	240-66695-4	
Sample Name	CFIIS-016-SO-	CFIIS-016-SO-	CFIIS-017-SO-	CFIIS-017-SO-	CFIIS-018-SO-0	CFIIS-018-SO-0	CFIIS-019-SO-	CFIIS-019-SO-	CFIIS-020-SO-0	CFIIS-DUP2-SO	CFIIS-021-SO-	CFIIS-021-SO-	CFIIS-022-SO-	CFIIS-022-SO-	CFIIS-023-SO-	CFIIS-023-SO-	CFIIS-024-SO-	CFIIS-024-SO-	CFIIS-024-SO-	
Sample Depth	0-0.5	0.5-2	0.5-2	0.5-2	0-0.5	0.5	0.5-2	0-0.5	0.5-2	0.5-2	0-0.5	0.5-2	0-0.5	0.5-2	0-0.5	0.5-2	0-0.5	0.5-2	0-0.5	
Chemical	0-0.5 ft	0.5-2 ft	0.5-2 ft	0.5-2 ft	0-0.5 ft	0.5 ft	0-0.5 ft	0-0.5 ft	0.5-2 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	
GENERAL CHEMISTRY ANIONS (mg/kg)																				
Fluoride	27.6	36.8 J	28.6	36.7	72.9 J-	16.6 J-	215 J-	70.5 J-	61.2 J-	60.4 J-	36.7 J-	251 J-	136 J-	732 J+	282 J+	39.3 J	44.6 J	592 J+	204 J+	

Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram

Appendix A-12c
Central Landfill ISS Area Soil (0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

Sample Location ID	CFIIS-025	CFIIS-025	CFIIS-026	CFIIS-026	CFIIS-027	CFIIS-027-DUP	CFIIS-027	CFIIS-028	CFIIS-028	CFIIS-029	CFIIS-029
Sample Lab IDs	240-66695-5	240-66695-6	240-66695-7	240-66695-8	240-66695-9	240-66695-10	240-66695-11	240-66695-12	240-66695-14	240-66588-5	240-66588-6
Sample Name	CFIIS-025-SO-	CFIIS-025-SO-0.5-	CFIIS-026-SO-0-	CFIIS-026-SO-0.5-	CFIIS-027-SO-0-	CFIIS-DUP3-SO	CFIIS-027-SO-0.5-	CFIIS-028-SO-0-	CFIIS-028-SO-0.5-	CFIIS-029-SO-0-	CFIIS-029-SO-0.5-
Sample Depth	0-0.5	2	0.5	2	0.5	0-0.5 ft	2	0.5	2	0.5	2
Chemical	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	7/1/2016	0.5-2 ft	0-0.5 ft	0.5-2 ft	0-0.5 ft	0.5-2 ft
GENERAL CHEMISTRY ANIONS (mg/kg)											
Fluoride	69.8	157 J+	617 J+	632 J+	244 J+	239 J+	946	183 J+	861 J+	39.9 J	53 J

Footnotes:

-- = not applicable

- = Result is biased low

+ = Result is biased high

ft = feet

ft-bgs = feet below ground surface

J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

mg/kg = milligram(s) per kilogram



Attachment B ProUCL Outputs

Preliminary - Under EPA and MDEQ Review

ProUCL Output
Main Plant Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L																		
1	UCL Statistics for Data Sets with Non-Detects																													
2																														
3	User Selected Options																													
4	Date/Time of Computation	ProUCL 5.17/17/2018 4:56:19 PM																												
5	From File	20180717_fluoride_for_proucl.xls																												
6	Full Precision	OFF																												
7	Confidence Coefficient	95%																												
8	Number of Bootstrap Operations	2000																												
9																														
10																														
11	Fluoride																													
12																														
13	General Statistics																													
14	Total Number of Observations	60		Number of Distinct Observations		60																								
15				Number of Missing Observations		0																								
16	Minimum	4.25				Mean		75.53																						
17	Maximum	571				Median		45.35																						
18	SD	92.23				Std. Error of Mean		11.91																						
19	Coefficient of Variation	1.221				Skewness		3.27																						
20																														
21	Normal GOF Test																													
22	Shapiro Wilk Test Statistic	0.668		Shapiro Wilk GOF Test																										
23	5% Shapiro Wilk P Value	0		Data Not Normal at 5% Significance Level																										
24	Lilliefors Test Statistic	0.233		Lilliefors GOF Test																										
25	5% Lilliefors Critical Value	0.114		Data Not Normal at 5% Significance Level																										
26	Data Not Normal at 5% Significance Level																													
27																														
28	Assuming Normal Distribution																													
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																									
30	95% Student's-t UCL				95% Adjusted-CLT UCL (Chen-1995)		100.5																							
31					95% Modified-t UCL (Johnson-1978)		96.27																							
32																														
33	Gamma GOF Test																													
34	A-D Test Statistic	0.999		Anderson-Darling Gamma GOF Test																										
35	5% A-D Critical Value	0.776		Data Not Gamma Distributed at 5% Significance Level																										
36	K-S Test Statistic	0.122		Kolmogorov-Smirnov Gamma GOF Test																										
37	5% K-S Critical Value	0.118		Data Not Gamma Distributed at 5% Significance Level																										
38	Data Not Gamma Distributed at 5% Significance Level																													
39																														
40	Gamma Statistics																													
41	k hat (MLE)	1.156		k star (bias corrected MLE)		1.11																								
42	Theta hat (MLE)	65.31		Theta star (bias corrected MLE)		68.06																								
43	nu hat (MLE)	138.8		nu star (bias corrected)		133.2																								
44	MLE Mean (bias corrected)	75.53		MLE Sd (bias corrected)		71.7																								
45					Approximate Chi Square Value (0.05)		107.5																							
46	Adjusted Level of Significance	0.046				Adjusted Chi Square Value		106.9																						
47																														
48	Assuming Gamma Distribution																													
49	95% Approximate Gamma UCL (use when n>=50))	93.56		95% Adjusted Gamma UCL (use when n<50)		94.06																								
50																														

ProUCL Output
Main Plant Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L
51												
52												
53												
54												
55												
56												
57												
58												
59												
60												
61												
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88												
89												

ProUCL Output
Main Plant Area Soil (0-12 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L											
1	UCL Statistics for Data Sets with Non-Detects																						
2																							
3	User Selected Options																						
4	Date/Time of Computation	ProUCL 5.17/17/2018 4:55:14 PM																					
5	From File	20180717_fluoride_for_proucl_a.xls																					
6	Full Precision	OFF																					
7	Confidence Coefficient	95%																					
8	Number of Bootstrap Operations	2000																					
9																							
10	Fluoride																						
11																							
12	General Statistics																						
13	Total Number of Observations	197	Number of Distinct Observations																				
14	Number of Detects	196	Number of Non-Detects																				
15	Number of Distinct Detects	183	Number of Distinct Non-Detects																				
16	Minimum Detect	1.29	Minimum Non-Detect																				
17	Maximum Detect	571	Maximum Non-Detect																				
18	Variance Detects	5721	Percent Non-Detects																				
19	Mean Detects	52.55	SD Detects																				
20	Median Detects	25.85	CV Detects																				
21	Skewness Detects	3.345	Kurtosis Detects																				
22	Mean of Logged Detects	3.228	SD of Logged Detects																				
23																							
24	Normal GOF Test on Detects Only																						
25	Shapiro Wilk Test Statistic	0.64	Normal GOF Test on Detected Observations Only																				
26	5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level																				
27	Lilliefors Test Statistic	0.249	Lilliefors GOF Test																				
28	5% Lilliefors Critical Value	0.0637	Detected Data Not Normal at 5% Significance Level																				
29	Detected Data Not Normal at 5% Significance Level																						
30																							
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs																						
32	KM Mean	52.29	KM Standard Error of Mean																				
33	KM SD	75.34	95% KM (BCA) UCL																				
34	95% KM (t) UCL	61.18	95% KM (Percentile Bootstrap) UCL																				
35	95% KM (z) UCL	61.14	95% KM Bootstrap t UCL																				
36	90% KM Chebyshev UCL	68.43	95% KM Chebyshev UCL																				
37	97.5% KM Chebyshev UCL	85.9	99% KM Chebyshev UCL																				
38																							
39	Gamma GOF Tests on Detected Observations Only																						
40	A-D Test Statistic	2.426	Anderson-Darling GOF Test																				
41	5% A-D Critical Value	0.793	Detected Data Not Gamma Distributed at 5% Significance Level																				
42	K-S Test Statistic	0.0868	Kolmogorov-Smirnov GOF																				
43	5% K-S Critical Value	0.0671	Detected Data Not Gamma Distributed at 5% Significance Level																				
44	Detected Data Not Gamma Distributed at 5% Significance Level																						
45																							
46	Gamma Statistics on Detected Data Only																						
47	k hat (MLE)	0.807	k star (bias corrected MLE)																				
48	Theta hat (MLE)	65.1	Theta star (bias corrected MLE)																				
49	nu hat (MLE)	316.5	nu star (bias corrected)																				
50	Mean (detects)	52.55																					
51																							

ProUCL Output
Main Plant Area Soil (0-12 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L																																				
52	Gamma ROS Statistics using Imputed Non-Detects																																															
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs																																															
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)																																															
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs																																															
56	This is especially true when the sample size is small.																																															
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates																																															
58	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">Minimum</td> <td style="width: 10%;">0.01</td> <td style="width: 10%;">Mean</td> <td style="width: 10%;">52.29</td> </tr> <tr> <td>Maximum</td> <td>571</td> <td>Median</td> <td>25.8</td> </tr> <tr> <td>SD</td> <td>75.53</td> <td>CV</td> <td>1.445</td> </tr> <tr> <td>k hat (MLE)</td> <td>0.775</td> <td>k star (bias corrected MLE)</td> <td>0.767</td> </tr> <tr> <td>Theta hat (MLE)</td> <td>67.46</td> <td>Theta star (bias corrected MLE)</td> <td>68.2</td> </tr> <tr> <td>nu hat (MLE)</td> <td>305.4</td> <td>nu star (bias corrected)</td> <td>302.1</td> </tr> <tr> <td>Adjusted Level of Significance (β)</td> <td>0.0488</td> <td></td> <td></td> </tr> <tr> <td>Approximate Chi Square Value (302.07, α)</td> <td>262.8</td> <td>Adjusted Chi Square Value (302.07, β)</td> <td>262.5</td> </tr> <tr> <td>95% Gamma Approximate UCL (use when n>=50)</td> <td>60.1</td> <td>95% Gamma Adjusted UCL (use when n<50)</td> <td>60.16</td> </tr> </table>												Minimum	0.01	Mean	52.29	Maximum	571	Median	25.8	SD	75.53	CV	1.445	k hat (MLE)	0.775	k star (bias corrected MLE)	0.767	Theta hat (MLE)	67.46	Theta star (bias corrected MLE)	68.2	nu hat (MLE)	305.4	nu star (bias corrected)	302.1	Adjusted Level of Significance (β)	0.0488			Approximate Chi Square Value (302.07, α)	262.8	Adjusted Chi Square Value (302.07, β)	262.5	95% Gamma Approximate UCL (use when n>=50)	60.1	95% Gamma Adjusted UCL (use when n<50)	60.16
Minimum	0.01	Mean	52.29																																													
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67	Estimates of Gamma Parameters using KM Estimates																																															
69	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">Mean (KM)</td> <td style="width: 10%;">52.29</td> <td style="width: 10%;">SD (KM)</td> <td style="width: 10%;">75.34</td> </tr> <tr> <td>Variance (KM)</td> <td>5676</td> <td>SE of Mean (KM)</td> <td>5.382</td> </tr> <tr> <td>k hat (KM)</td> <td>0.482</td> <td>k star (KM)</td> <td>0.478</td> </tr> <tr> <td>nu hat (KM)</td> <td>189.8</td> <td>nu star (KM)</td> <td>188.2</td> </tr> <tr> <td>theta hat (KM)</td> <td>108.6</td> <td>theta star (KM)</td> <td>109.5</td> </tr> <tr> <td>80% gamma percentile (KM)</td> <td>85.68</td> <td>90% gamma percentile (KM)</td> <td>142.8</td> </tr> <tr> <td>95% gamma percentile (KM)</td> <td>204.1</td> <td>99% gamma percentile (KM)</td> <td>355.7</td> </tr> </table>												Mean (KM)	52.29	SD (KM)	75.34	Variance (KM)	5676	SE of Mean (KM)	5.382	k hat (KM)	0.482	k star (KM)	0.478	nu hat (KM)	189.8	nu star (KM)	188.2	theta hat (KM)	108.6	theta star (KM)	109.5	80% gamma percentile (KM)	85.68	90% gamma percentile (KM)	142.8	95% gamma percentile (KM)	204.1	99% gamma percentile (KM)	355.7								
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95% gamma percentile (KM)	204.1	99% gamma percentile (KM)	355.7																																													
77	Gamma Kaplan-Meier (KM) Statistics																																															
78	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">Approximate Chi Square Value (188.21, α)</td> <td style="width: 10%;">157.5</td> <td style="width: 10%;">Adjusted Chi Square Value (188.21, β)</td> <td style="width: 10%;">157.3</td> </tr> <tr> <td>95% Gamma Approximate KM-UCL (use when n>=50)</td> <td>62.49</td> <td>95% Gamma Adjusted KM-UCL (use when n<50)</td> <td>62.58</td> </tr> </table>												Approximate Chi Square Value (188.21, α)	157.5	Adjusted Chi Square Value (188.21, β)	157.3	95% Gamma Approximate KM-UCL (use when n>=50)	62.49	95% Gamma Adjusted KM-UCL (use when n<50)	62.58																												
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81	Lognormal GOF Test on Detected Observations Only																																															
82	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">Shapiro Wilk Approximate Test Statistic</td> <td style="width: 10%;">0.976</td> <td style="width: 10%;">Shapiro Wilk GOF Test</td> <td style="width: 10%;"></td> </tr> <tr> <td>5% Shapiro Wilk P Value</td> <td>0.137</td> <td>Detected Data appear Lognormal at 5% Significance Level</td> <td></td> </tr> <tr> <td>Lilliefors Test Statistic</td> <td>0.0309</td> <td>Lilliefors GOF Test</td> <td></td> </tr> <tr> <td>5% Lilliefors Critical Value</td> <td>0.0637</td> <td>Detected Data appear Lognormal at 5% Significance Level</td> <td></td> </tr> </table>											Shapiro Wilk Approximate Test Statistic	0.976	Shapiro Wilk GOF Test		5% Shapiro Wilk P Value	0.137	Detected Data appear Lognormal at 5% Significance Level		Lilliefors Test Statistic	0.0309	Lilliefors GOF Test		5% Lilliefors Critical Value	0.0637	Detected Data appear Lognormal at 5% Significance Level																						
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5% Shapiro Wilk P Value	0.137	Detected Data appear Lognormal at 5% Significance Level																																														
Lilliefors Test Statistic	0.0309	Lilliefors GOF Test																																														
5% Lilliefors Critical Value	0.0637	Detected Data appear Lognormal at 5% Significance Level																																														
86	Detected Data appear Lognormal at 5% Significance Level																																															
88	Lognormal ROS Statistics Using Imputed Non-Detects																																															
89	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">Mean in Original Scale</td> <td style="width: 10%;">52.29</td> <td style="width: 10%;">Mean in Log Scale</td> <td style="width: 10%;">3.209</td> </tr> <tr> <td>SD in Original Scale</td> <td>75.53</td> <td>SD in Log Scale</td> <td>1.293</td> </tr> <tr> <td>95% t UCL (assumes normality of ROS data)</td> <td>61.18</td> <td>95% Percentile Bootstrap UCL</td> <td>61.33</td> </tr> <tr> <td>95% BCA Bootstrap UCL</td> <td>62.66</td> <td>95% Bootstrap t UCL</td> <td>63.04</td> </tr> <tr> <td>95% H-UCL (Log ROS)</td> <td>71.62</td> <td></td> <td></td> </tr> </table>												Mean in Original Scale	52.29	Mean in Log Scale	3.209	SD in Original Scale	75.53	SD in Log Scale	1.293	95% t UCL (assumes normality of ROS data)	61.18	95% Percentile Bootstrap UCL	61.33	95% BCA Bootstrap UCL	62.66	95% Bootstrap t UCL	63.04	95% H-UCL (Log ROS)	71.62																		
Mean in Original Scale	52.29	Mean in Log Scale	3.209																																													
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95% H-UCL (Log ROS)	71.62																																															
94	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution																																															
96	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">KM Mean (logged)</td> <td style="width: 10%;">3.203</td> <td style="width: 10%;">KM Geo Mean</td> <td style="width: 10%;">24.6</td> </tr> <tr> <td>KM SD (logged)</td> <td>1.31</td> <td>95% Critical H Value (KM-Log)</td> <td>2.467</td> </tr> <tr> <td>KM Standard Error of Mean (logged)</td> <td>0.0936</td> <td>95% H-UCL (KM -Log)</td> <td>73.06</td> </tr> <tr> <td>KM SD (logged)</td> <td>1.31</td> <td>95% Critical H Value (KM-Log)</td> <td>2.467</td> </tr> <tr> <td>KM Standard Error of Mean (logged)</td> <td>0.0936</td> <td></td> <td></td> </tr> </table>												KM Mean (logged)	3.203	KM Geo Mean	24.6	KM SD (logged)	1.31	95% Critical H Value (KM-Log)	2.467	KM Standard Error of Mean (logged)	0.0936	95% H-UCL (KM -Log)	73.06	KM SD (logged)	1.31	95% Critical H Value (KM-Log)	2.467	KM Standard Error of Mean (logged)	0.0936																		
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KM SD (logged)	1.31	95% Critical H Value (KM-Log)	2.467																																													
KM Standard Error of Mean (logged)	0.0936																																															
101	DL/2 Statistics																																															
102																																																

ProUCL Output
Main Plant Area Soil (0-12 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L						
103	DL/2 Normal						DL/2 Log-Transformed											
104	Mean in Original Scale						Mean in Log Scale											
105	SD in Original Scale						SD in Log Scale											
106	95% t UCL (Assumes normality)						95% H-Stat UCL											
107	DL/2 is not a recommended method, provided for comparisons and historical reasons																	
108																		
109	Nonparametric Distribution Free UCL Statistics																	
110	Detected Data appear Lognormal Distributed at 5% Significance Level																	
111																		
112	Suggested UCL to Use																	
113	KM H-UCL						73.06											
114																		
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.																	
116	Recommendations are based upon data size, data distribution, and skewness.																	
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichile, and Lee (2006).																	
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.																	
119																		

ProUCL Output
North Percolation Pond Area Soil (0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L											
1	UCL Statistics for Data Sets with Non-Detects																						
2																							
3	User Selected Options																						
4	Date/Time of Computation	ProUCL 5.17/17/2018 4:54:06 PM																					
5	From File	20180717_fluoride_for_proucl_b.xls																					
6	Full Precision	OFF																					
7	Confidence Coefficient	95%																					
8	Number of Bootstrap Operations	2000																					
9																							
10																							
11	Fluoride																						
12																							
13	General Statistics																						
14	Total Number of Observations	18										Number of Distinct Observations 18											
15												Number of Missing Observations 0											
16	Minimum	7.98										Mean 106.7											
17	Maximum	258										Median 82.75											
18	SD	76.79										Std. Error of Mean 18.1											
19	Coefficient of Variation	0.72										Skewness 0.745											
20																							
21	Normal GOF Test																						
22	Shapiro Wilk Test Statistic	0.905										Shapiro Wilk GOF Test											
23	5% Shapiro Wilk Critical Value	0.897										Data appear Normal at 5% Significance Level											
24	Lilliefors Test Statistic	0.178										Lilliefors GOF Test											
25	5% Lilliefors Critical Value	0.202										Data appear Normal at 5% Significance Level											
26	Data appear Normal at 5% Significance Level																						
27																							
28	Assuming Normal Distribution																						
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																		
30	95% Student's-t UCL	138.1										95% Adjusted-CLT UCL (Chen-1995) 139.8											
31												95% Modified-t UCL (Johnson-1978) 138.7											
32																							
33	Gamma GOF Test																						
34	A-D Test Statistic	0.278										Anderson-Darling Gamma GOF Test											
35	5% A-D Critical Value	0.754										Detected data appear Gamma Distributed at 5% Significance Level											
36	K-S Test Statistic	0.122										Kolmogorov-Smirnov Gamma GOF Test											
37	5% K-S Critical Value	0.207										Detected data appear Gamma Distributed at 5% Significance Level											
38	Detected data appear Gamma Distributed at 5% Significance Level																						
39																							
40	Gamma Statistics																						
41	k hat (MLE)	1.778										k star (bias corrected MLE) 1.519											
42	Theta hat (MLE)	59.99										Theta star (bias corrected MLE) 70.23											
43	nu hat (MLE)	64.01										nu star (bias corrected) 54.67											
44	MLE Mean (bias corrected)	106.7										MLE Sd (bias corrected) 86.54											
45												Approximate Chi Square Value (0.05) 38.68											
46	Adjusted Level of Significance	0.0357										Adjusted Chi Square Value 37.39											
47																							
48	Assuming Gamma Distribution																						
49	95% Approximate Gamma UCL (use when n>=50))	150.7										95% Adjusted Gamma UCL (use when n<50) 155.9											
50																							
51	Lognormal GOF Test																						

ProUCL Output
North Percolation Pond Area Soil (0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

A	B	C	D	E	F	G	H	I	J	K	L
52				Shapiro Wilk Test Statistic	0.937						Shapiro Wilk Lognormal GOF Test
53				5% Shapiro Wilk Critical Value	0.897						Data appear Lognormal at 5% Significance Level
54				Lilliefors Test Statistic	0.141						Lilliefors Lognormal GOF Test
55				5% Lilliefors Critical Value	0.202						Data appear Lognormal at 5% Significance Level
56											Data appear Lognormal at 5% Significance Level
57											
58											Lognormal Statistics
59				Minimum of Logged Data	2.077						Mean of logged Data 4.363
60				Maximum of Logged Data	5.553						SD of logged Data 0.897
61											
62											Assuming Lognormal Distribution
63				95% H-UCL	201.9						90% Chebyshev (MVUE) UCL 193
64				95% Chebyshev (MVUE) UCL	228.8						97.5% Chebyshev (MVUE) UCL 278.6
65				99% Chebyshev (MVUE) UCL	376.2						
66											
67											Nonparametric Distribution Free UCL Statistics
68											Data appear to follow a Discernible Distribution at 5% Significance Level
69											
70											Nonparametric Distribution Free UCLs
71				95% CLT UCL	136.4						95% Jackknife UCL 138.1
72				95% Standard Bootstrap UCL	136						95% Bootstrap-t UCL 143.7
73				95% Hall's Bootstrap UCL	138.8						95% Percentile Bootstrap UCL 135.8
74				95% BCA Bootstrap UCL	135.7						
75				90% Chebyshev(Mean, Sd) UCL	161						95% Chebyshev(Mean, Sd) UCL 185.5
76				97.5% Chebyshev(Mean, Sd) UCL	219.7						99% Chebyshev(Mean, Sd) UCL 286.7
77											
78											Suggested UCL to Use
79				95% Student's-t UCL	138.1						
80											
81											Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
82											Recommendations are based upon data size, data distribution, and skewness.
83											These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
84											However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.
85											

ProUCL Output
North Percolation Pond Area Soil (0-12 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L											
1	UCL Statistics for Data Sets with Non-Detects																						
2	<hr/>																						
3	User Selected Options																						
4	<hr/>																						
5	Date/Time of Computation	ProUCL 5.17/17/2018 4:53:01 PM																					
6	<hr/>																						
7	From File	20180717_fluoride_for_proucl.xls																					
8	Full Precision	OFF																					
9	<hr/>																						
10	Confidence Coefficient	95%																					
11	Number of Bootstrap Operations	2000																					
12	<hr/>																						
13	Fluoride																						
14	<hr/>																						
15	General Statistics																						
16	Total Number of Observations	27		Number of Distinct Observations		27																	
17						Number of Missing Observations		0															
18	Minimum	0.87				Mean		78.85															
19	Maximum	258				Median		50.2															
20	SD	74.5				Std. Error of Mean		14.34															
21	Coefficient of Variation	0.945				Skewness		1.197															
22	<hr/>																						
23	Normal GOF Test																						
24	Shapiro Wilk Test Statistic	0.843		Shapiro Wilk GOF Test																			
25	5% Shapiro Wilk Critical Value	0.923		Data Not Normal at 5% Significance Level																			
26	Lilliefors Test Statistic	0.236		Lilliefors GOF Test																			
27	5% Lilliefors Critical Value	0.167		Data Not Normal at 5% Significance Level																			
28	<hr/>																						
29	Assuming Normal Distribution																						
30	95% Normal UCL				95% UCLs (Adjusted for Skewness)																		
31	95% Student's-t UCL	103.3		95% Adjusted-CLT UCL (Chen-1995)		106																	
32						95% Modified-t UCL (Johnson-1978)		103.9															
33	<hr/>																						
34	Gamma GOF Test																						
35	A-D Test Statistic	0.238		Anderson-Darling Gamma GOF Test																			
36	5% A-D Critical Value	0.773		Detected data appear Gamma Distributed at 5% Significance Level																			
37	K-S Test Statistic	0.106		Kolmogorov-Smirnov Gamma GOF Test																			
38	5% K-S Critical Value	0.173		Detected data appear Gamma Distributed at 5% Significance Level																			
39	<hr/>																						
40	Gamma Statistics																						
41	k hat (MLE)	1.013				k star (bias corrected MLE)		0.925															
42	Theta hat (MLE)	77.85				Theta star (bias corrected MLE)		85.24															
43	nu hat (MLE)	54.7				nu star (bias corrected)		49.95															
44	MLE Mean (bias corrected)	78.85				MLE Sd (bias corrected)		81.99															
45						Approximate Chi Square Value (0.05)		34.72															
46	Adjusted Level of Significance	0.0401				Adjusted Chi Square Value		33.91															
47	<hr/>																						
48	Assuming Gamma Distribution																						
49	95% Approximate Gamma UCL (use when n>=50)	113.4				95% Adjusted Gamma UCL (use when n<50)		116.2															
50	<hr/>																						

ProUCL Output
North Percolation Pond Area Soil (0-12 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L		
Lognormal GOF Test														
51														
52					Shapiro Wilk Test Statistic	0.92								
53					5% Shapiro Wilk Critical Value	0.923								
54					Lilliefors Test Statistic	0.13								
55					5% Lilliefors Critical Value	0.167								
56					Data appear Approximate Lognormal at 5% Significance Level									
57														
58					Lognormal Statistics									
59					Minimum of Logged Data	-0.139					Mean of logged Data	3.799		
60					Maximum of Logged Data	5.553					SD of logged Data	1.311		
61														
62					Assuming Lognormal Distribution									
63					95% H-UCL	225.2					90% Chebyshev (MVUE) UCL	191.2		
64					95% Chebyshev (MVUE) UCL	232.5					97.5% Chebyshev (MVUE) UCL	290		
65					99% Chebyshev (MVUE) UCL	402.8								
66														
67					Nonparametric Distribution Free UCL Statistics									
68					Data appear to follow a Discernible Distribution at 5% Significance Level									
69														
70					Nonparametric Distribution Free UCLs									
71					95% CLT UCL	102.4					95% Jackknife UCL	103.3		
72					95% Standard Bootstrap UCL	102.6					95% Bootstrap-t UCL	109.3		
73					95% Hall's Bootstrap UCL	104.8					95% Percentile Bootstrap UCL	103.7		
74					95% BCA Bootstrap UCL	106.6								
75					90% Chebyshev(Mean, Sd) UCL	121.9					95% Chebyshev(Mean, Sd) UCL	141.3		
76					97.5% Chebyshev(Mean, Sd) UCL	168.4					99% Chebyshev(Mean, Sd) UCL	221.5		
77														
78					Suggested UCL to Use									
79					95% Adjusted Gamma UCL	116.2								
80														
81					Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.									
82					Recommendations are based upon data size, data distribution, and skewness.									
83					These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).									
84					However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.									
85														

ProUCL Output
Central Landfills Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L											
1	UCL Statistics for Data Sets with Non-Detects																						
2																							
3	User Selected Options																						
4	Date/Time of Computation	ProUCL 5.17/17/2018 4:52:07 PM																					
5	From File	20180717_fluoride_for_proucl_d.xls																					
6	Full Precision	OFF																					
7	Confidence Coefficient	95%																					
8	Number of Bootstrap Operations	2000																					
9																							
10																							
11	Fluoride																						
12																							
13	General Statistics																						
14	Total Number of Observations	27										Number of Distinct Observations 27											
15												Number of Missing Observations 0											
16	Minimum	9.33										Mean 63.1											
17	Maximum	210										Median 56.5											
18	SD	50.89										Std. Error of Mean 9.794											
19	Coefficient of Variation	0.807										Skewness 1.325											
20																							
21	Normal GOF Test																						
22	Shapiro Wilk Test Statistic	0.864										Shapiro Wilk GOF Test											
23	5% Shapiro Wilk Critical Value	0.923										Data Not Normal at 5% Significance Level											
24	Lilliefors Test Statistic	0.173										Lilliefors GOF Test											
25	5% Lilliefors Critical Value	0.167										Data Not Normal at 5% Significance Level											
26	Data Not Normal at 5% Significance Level																						
27																							
28	Assuming Normal Distribution																						
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																		
30	95% Student's-t UCL	79.8										95% Adjusted-CLT UCL (Chen-1995) 81.88											
31												95% Modified-t UCL (Johnson-1978) 80.22											
32																							
33	Gamma GOF Test																						
34	A-D Test Statistic	0.365										Anderson-Darling Gamma GOF Test											
35	5% A-D Critical Value	0.761										Detected data appear Gamma Distributed at 5% Significance Level											
36	K-S Test Statistic	0.116										Kolmogorov-Smirnov Gamma GOF Test											
37	5% K-S Critical Value	0.171										Detected data appear Gamma Distributed at 5% Significance Level											
38	Detected data appear Gamma Distributed at 5% Significance Level																						
39																							
40	Gamma Statistics																						
41	k hat (MLE)	1.664										k star (bias corrected MLE) 1.504											
42	Theta hat (MLE)	37.92										Theta star (bias corrected MLE) 41.96											
43	nu hat (MLE)	89.85										nu star (bias corrected) 81.2											
44	MLE Mean (bias corrected)	63.1										MLE Sd (bias corrected) 51.45											
45												Approximate Chi Square Value (0.05) 61.44											
46	Adjusted Level of Significance	0.0401										Adjusted Chi Square Value 60.34											
47																							
48	Assuming Gamma Distribution																						
49	95% Approximate Gamma UCL (use when n>=50)	83.4										95% Adjusted Gamma UCL (use when n<50) 84.92											
50																							

ProUCL Output
Central Landfills Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

ProUCL Output
Central Landfills Area Soil (0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L											
1	UCL Statistics for Data Sets with Non-Detects																						
2																							
3	User Selected Options																						
4	Date/Time of Computation	ProUCL 5.17/17/2018 4:51:14 PM																					
5																							
6	From File	20180717_fluoride_for_proucl_e.xls																					
7	Full Precision	OFF																					
8	Confidence Coefficient	95%																					
9	Number of Bootstrap Operations	2000																					
10																							
11	Fluoride																						
12																							
13	General Statistics																						
14	Total Number of Observations	54			Number of Distinct Observations		52																
15					Number of Missing Observations		0																
16	Minimum	5.6			Mean		58.44																
17	Maximum	210			Median		42.2																
18	SD	48.54			Std. Error of Mean		6.606																
19	Coefficient of Variation	0.831			Skewness		1.311																
20																							
21	Normal GOF Test																						
22	Shapiro Wilk Test Statistic	0.856	Shapiro Wilk GOF Test																				
23	5% Shapiro Wilk P Value	7.3516E-7	Data Not Normal at 5% Significance Level																				
24	Lilliefors Test Statistic	0.156	Lilliefors GOF Test																				
25	5% Lilliefors Critical Value	0.12	Data Not Normal at 5% Significance Level																				
26	Data Not Normal at 5% Significance Level																						
27																							
28	Assuming Normal Distribution																						
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																		
30	95% Student's-t UCL		69.5			95% Adjusted-CLT UCL (Chen-1995)		70.57															
31						95% Modified-t UCL (Johnson-1978)		69.7															
32																							
33	Gamma GOF Test																						
34	A-D Test Statistic	0.536	Anderson-Darling Gamma GOF Test																				
35	5% A-D Critical Value	0.767	Detected data appear Gamma Distributed at 5% Significance Level																				
36	K-S Test Statistic	0.101	Kolmogorov-Smirnov Gamma GOF Test																				
37	5% K-S Critical Value	0.123	Detected data appear Gamma Distributed at 5% Significance Level																				
38	Detected data appear Gamma Distributed at 5% Significance Level																						
39																							
40	Gamma Statistics																						
41	k hat (MLE)	1.562			k star (bias corrected MLE)		1.488																
42	Theta hat (MLE)	37.4			Theta star (bias corrected MLE)		39.28																
43	nu hat (MLE)	168.7			nu star (bias corrected)		160.7																
44	MLE Mean (bias corrected)	58.44			MLE Sd (bias corrected)		47.91																
45					Approximate Chi Square Value (0.05)		132.4																
46	Adjusted Level of Significance	0.0456			Adjusted Chi Square Value		131.7																
47																							
48	Assuming Gamma Distribution																						
49	95% Approximate Gamma UCL (use when n>=50)	70.94			95% Adjusted Gamma UCL (use when n<50)		71.32																
50																							

ProUCL Output
Central Landfills Area Soil (0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

ProUCL Output
Central Landfills Area Soil (0-12 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L															
1	UCL Statistics for Data Sets with Non-Detects																										
2																											
3	User Selected Options																										
4	Date/Time of Computation	ProUCL 5.17/17/2018 4:50:13 PM																									
5	From File	20180717_fluoride_for_proucl.xls																									
6	Full Precision	OFF																									
7	Confidence Coefficient	95%																									
8	Number of Bootstrap Operations	2000																									
9																											
10																											
11	Fluoride																										
12																											
13	General Statistics																										
14	Total Number of Observations	81			Number of Distinct Observations		77																				
15					Number of Missing Observations		0																				
16	Minimum	0.35			Mean		43.9																				
17	Maximum	210			Median		25.9																				
18	SD	45.54			Std. Error of Mean		5.06																				
19	Coefficient of Variation	1.037			Skewness		1.657																				
20																											
21	Normal GOF Test																										
22	Shapiro Wilk Test Statistic	0.805	Shapiro Wilk GOF Test																								
23	5% Shapiro Wilk P Value	3.331E-15	Data Not Normal at 5% Significance Level																								
24	Lilliefors Test Statistic	0.185	Lilliefors GOF Test																								
25	5% Lilliefors Critical Value	0.0985	Data Not Normal at 5% Significance Level																								
26	Data Not Normal at 5% Significance Level																										
27																											
28	Assuming Normal Distribution																										
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																						
30	95% Student's-t UCL				52.32	95% Adjusted-CLT UCL (Chen-1995)		53.22																			
31						95% Modified-t UCL (Johnson-1978)		52.48																			
32																											
33	Gamma GOF Test																										
34	A-D Test Statistic	0.465	Anderson-Darling Gamma GOF Test																								
35	5% A-D Critical Value	0.783	Detected data appear Gamma Distributed at 5% Significance Level																								
36	K-S Test Statistic	0.0706	Kolmogorov-Smirnov Gamma GOF Test																								
37	5% K-S Critical Value	0.102	Detected data appear Gamma Distributed at 5% Significance Level																								
38	Detected data appear Gamma Distributed at 5% Significance Level																										
39																											
40	Gamma Statistics																										
41	k hat (MLE)	0.982	k star (bias corrected MLE)		0.954																						
42	Theta hat (MLE)	44.7	Theta star (bias corrected MLE)		46.02																						
43	nu hat (MLE)	159.1	nu star (bias corrected)		154.5																						
44	MLE Mean (bias corrected)	43.9	MLE Sd (bias corrected)		44.95																						
45					Approximate Chi Square Value (0.05)		126.8																				
46	Adjusted Level of Significance	0.047			Adjusted Chi Square Value		126.4																				
47																											
48	Assuming Gamma Distribution																										
49	95% Approximate Gamma UCL (use when n>=50)	53.5	95% Adjusted Gamma UCL (use when n<50)		53.69																						
50																											

ProUCL Output
Central Landfills Area Soil (0-12 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L
51												
52												
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Preliminary and Unedited Report

Lognormal GOF Test

Shapiro Wilk Test Statistic | 0.963 | **Shapiro Wilk Lognormal GOF Test**

5% Shapiro Wilk P Value | 0.0786 | Data appear Lognormal at 5% Significance Level

Lilliefors Test Statistic | 0.0735 | **Lilliefors Lognormal GOF Test**

5% Lilliefors Critical Value | 0.0985 | Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data | -1.05 | Mean of logged Data | 3.193

Maximum of Logged Data | 5.347 | SD of logged Data | 1.233

Assuming Lognormal Distribution

95% H-UCL | 73.17 | 90% Chebyshev (MVUE) UCL | 78.11

95% Chebyshev (MVUE) UCL | 90.27 | 97.5% Chebyshev (MVUE) UCL | 107.2

99% Chebyshev (MVUE) UCL | 140.3 |

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL | 52.22 | 95% Jackknife UCL | 52.32

95% Standard Bootstrap UCL | 52.16 | 95% Bootstrap-t UCL | 54.17

95% Hall's Bootstrap UCL | 53.15 | 95% Percentile Bootstrap UCL | 52.21

95% BCA Bootstrap UCL | 53.71 |

90% Chebyshev(Mean, Sd) UCL | 59.08 | 95% Chebyshev(Mean, Sd) UCL | 65.95

97.5% Chebyshev(Mean, Sd) UCL | 75.5 | 99% Chebyshev(Mean, Sd) UCL | 94.24

Suggested UCL to Use

95% Approximate Gamma UCL | 53.5 |

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL Output
North-Central Undeveloped Area (surface water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L																					
1	UCL Statistics for Data Sets with Non-Detects																																
2																																	
3	User Selected Options																																
4	Date/Time of Computation	ProUCL 5.17/17/2018 4:48:27 PM																															
5	From File	20180717_fluoride_for_proucl_g.xls																															
6	Full Precision	OFF																															
7	Confidence Coefficient	95%																															
8	Number of Bootstrap Operations	2000																															
9																																	
10																																	
11	Fluoride																																
12																																	
13	General Statistics																																
14	Total Number of Observations	10			Number of Distinct Observations		10																										
15					Number of Missing Observations		0																										
16	Minimum	39.2			Mean		218																										
17	Maximum	473			Median		206																										
18	SD	114.8			Std. Error of Mean		36.32																										
19	Coefficient of Variation	0.527			Skewness		0.982																										
20																																	
21	Normal GOF Test																																
22	Shapiro Wilk Test Statistic	0.927	Shapiro Wilk GOF Test																														
23	5% Shapiro Wilk Critical Value	0.842	Data appear Normal at 5% Significance Level																														
24	Lilliefors Test Statistic	0.214	Lilliefors GOF Test																														
25	5% Lilliefors Critical Value	0.262	Data appear Normal at 5% Significance Level																														
26	Data appear Normal at 5% Significance Level																																
27																																	
28	Assuming Normal Distribution																																
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																												
30	95% Student's-t UCL				95% Adjusted-CLT UCL (Chen-1995) 289.8																												
31					95% Modified-t UCL (Johnson-1978) 286.5																												
32																																	
33	Gamma GOF Test																																
34	A-D Test Statistic	0.391	Anderson-Darling Gamma GOF Test																														
35	5% A-D Critical Value	0.731	Detected data appear Gamma Distributed at 5% Significance Level																														
36	K-S Test Statistic	0.184	Kolmogorov-Smirnov Gamma GOF Test																														
37	5% K-S Critical Value	0.268	Detected data appear Gamma Distributed at 5% Significance Level																														
38	Detected data appear Gamma Distributed at 5% Significance Level																																
39																																	
40	Gamma Statistics																																
41	k hat (MLE)	3.404	k star (bias corrected MLE)		2.449																												
42	Theta hat (MLE)	64.05	Theta star (bias corrected MLE)		89.01																												
43	nu hat (MLE)	68.08	nu star (bias corrected)		48.99																												
44	MLE Mean (bias corrected)	218	MLE Sd (bias corrected)		139.3																												
45					Approximate Chi Square Value (0.05) 33.92																												
46	Adjusted Level of Significance	0.0267			Adjusted Chi Square Value 31.75																												
47																																	
48	Assuming Gamma Distribution																																
49	95% Approximate Gamma UCL (use when n>=50))	314.9	95% Adjusted Gamma UCL (use when n<50) 336.4																														
50																																	

ProUCL Output
North-Central Undeveloped Area (surface water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

ProUCL Output
Western Undeveloped Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L															
1	UCL Statistics for Data Sets with Non-Detects																										
2																											
3	User Selected Options																										
4	Date/Time of Computation	ProUCL 5.17/17/2018 4:47:36 PM																									
5																											
6	From File	20180717_fluoride_for_proucl_h.xls																									
7	Full Precision	OFF																									
8	Confidence Coefficient	95%																									
9	Number of Bootstrap Operations	2000																									
10																											
11	Fluoride																										
12																											
13	General Statistics																										
14	Total Number of Observations	11		Number of Distinct Observations		11																					
15				Number of Missing Observations		0																					
16	Minimum	1.78				Mean		8.178																			
17	Maximum	15.4				Median		8.31																			
18	SD	4.576				Std. Error of Mean		1.38																			
19	Coefficient of Variation	0.56				Skewness		0.111																			
20																											
21	Normal GOF Test																										
22	Shapiro Wilk Test Statistic	0.951		Shapiro Wilk GOF Test																							
23	5% Shapiro Wilk Critical Value	0.85		Data appear Normal at 5% Significance Level																							
24	Lilliefors Test Statistic	0.149		Lilliefors GOF Test																							
25	5% Lilliefors Critical Value	0.251		Data appear Normal at 5% Significance Level																							
26	Data appear Normal at 5% Significance Level																										
27																											
28	Assuming Normal Distribution																										
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																						
30	95% Student's-t UCL				10.68		95% Adjusted-CLT UCL (Chen-1995)		10.5																		
31							95% Modified-t UCL (Johnson-1978)		10.69																		
32																											
33	Gamma GOF Test																										
34	A-D Test Statistic	0.326		Anderson-Darling Gamma GOF Test																							
35	5% A-D Critical Value	0.735		Detected data appear Gamma Distributed at 5% Significance Level																							
36	K-S Test Statistic	0.19		Kolmogorov-Smirnov Gamma GOF Test																							
37	5% K-S Critical Value	0.257		Detected data appear Gamma Distributed at 5% Significance Level																							
38	Detected data appear Gamma Distributed at 5% Significance Level																										
39																											
40	Gamma Statistics																										
41	k hat (MLE)	2.751		k star (bias corrected MLE)		2.061																					
42	Theta hat (MLE)	2.973		Theta star (bias corrected MLE)		3.968																					
43	nu hat (MLE)	60.52		nu star (bias corrected)		45.35																					
44	MLE Mean (bias corrected)	8.178		MLE Sd (bias corrected)		5.696																					
45							Approximate Chi Square Value (0.05)		30.9																		
46	Adjusted Level of Significance	0.0278				Adjusted Chi Square Value		28.97																			
47																											
48	Assuming Gamma Distribution																										
49	95% Approximate Gamma UCL (use when n>=50))	12		95% Adjusted Gamma UCL (use when n<50)		12.8																					
50																											

ProUCL Output
Western Undeveloped Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L
51	Lognormal GOF Test											
52			Shapiro Wilk Test Statistic		0.913							
53			5% Shapiro Wilk Critical Value		0.85							
54			Lilliefors Test Statistic		0.187							
55			5% Lilliefors Critical Value		0.251							
56	Data appear Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59			Minimum of Logged Data		0.577							Mean of logged Data 1.909
60			Maximum of Logged Data		2.734							SD of logged Data 0.713
61												
62	Assuming Lognormal Distribution											
63			95% H-UCL		15.23							90% Chebyshev (MVUE) UCL 14.12
64			95% Chebyshev (MVUE) UCL		16.69							97.5% Chebyshev (MVUE) UCL 20.25
65			99% Chebyshev (MVUE) UCL		27.24							
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71			95% CLT UCL		10.45							95% Jackknife UCL 10.68
72			95% Standard Bootstrap UCL		10.36							95% Bootstrap-t UCL 10.66
73			95% Hall's Bootstrap UCL		10.56							95% Percentile Bootstrap UCL 10.49
74			95% BCA Bootstrap UCL		10.38							
75			90% Chebyshev(Mean, Sd) UCL		12.32							95% Chebyshev(Mean, Sd) UCL 14.19
76			97.5% Chebyshev(Mean, Sd) UCL		16.79							99% Chebyshev(Mean, Sd) UCL 21.91
77												
78	Suggested UCL to Use											
79			95% Student's-t UCL		10.68							
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

ProUCL Output
Western Undeveloped Area (surface water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L																	
1	UCL Statistics for Data Sets with Non-Detects																												
2																													
3	User Selected Options																												
4	Date/Time of Computation	ProUCL 5.17/17/2018 4:45:28 PM																											
5																													
6	From File	20180717_fluoride_for_proucl.j.xls																											
7	Full Precision	OFF																											
8	Confidence Coefficient	95%																											
9	Number of Bootstrap Operations	2000																											
10																													
11	Fluoride																												
12																													
13	General Statistics																												
14	Total Number of Observations	16		Number of Distinct Observations		13																							
15				Number of Missing Observations		0																							
16	Minimum	55.8		Mean		114.8																							
17	Maximum	137		Median		125.5																							
18	SD	28.71		Std. Error of Mean		7.178																							
19	Coefficient of Variation	0.25		Skewness		-1.5																							
20																													
21	Normal GOF Test																												
22	Shapiro Wilk Test Statistic	0.716		Shapiro Wilk GOF Test																									
23	5% Shapiro Wilk Critical Value	0.887		Data Not Normal at 5% Significance Level																									
24	Lilliefors Test Statistic	0.274		Lilliefors GOF Test																									
25	5% Lilliefors Critical Value	0.213		Data Not Normal at 5% Significance Level																									
26	Data Not Normal at 5% Significance Level																												
27																													
28	Assuming Normal Distribution																												
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																								
30	95% Student's-t UCL				95% Adjusted-CLT UCL (Chen-1995) 123.7																								
31					95% Modified-t UCL (Johnson-1978) 126.9																								
32																													
33	Gamma GOF Test																												
34	A-D Test Statistic	2.341		Anderson-Darling Gamma GOF Test																									
35	5% A-D Critical Value	0.738		Data Not Gamma Distributed at 5% Significance Level																									
36	K-S Test Statistic	0.316		Kolmogorov-Smirnov Gamma GOF Test																									
37	5% K-S Critical Value	0.215		Data Not Gamma Distributed at 5% Significance Level																									
38	Data Not Gamma Distributed at 5% Significance Level																												
39																													
40	Gamma Statistics																												
41	k hat (MLE)	12.57		k star (bias corrected MLE)		10.26																							
42	Theta hat (MLE)	9.127		Theta star (bias corrected MLE)		11.19																							
43	nu hat (MLE)	402.3		nu star (bias corrected)		328.2																							
44	MLE Mean (bias corrected)	114.8		MLE Sd (bias corrected)		35.83																							
45					Approximate Chi Square Value (0.05) 287.2																								
46	Adjusted Level of Significance	0.0335				Adjusted Chi Square Value 282.9																							
47																													
48	Assuming Gamma Distribution																												
49	95% Approximate Gamma UCL (use when n>=50))	131.1		95% Adjusted Gamma UCL (use when n<50))		133.1																							
50																													

ProUCL Output
Western Undeveloped Area (surface water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L
51	Lognormal GOF Test											
52			Shapiro Wilk Test Statistic		0.663							
53			5% Shapiro Wilk Critical Value		0.887							
54			Lilliefors Test Statistic		0.333							
55			5% Lilliefors Critical Value		0.213							
56	Data Not Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59			Minimum of Logged Data		4.022							Mean of logged Data 4.702
60			Maximum of Logged Data		4.92							SD of logged Data 0.317
61												
62	Assuming Lognormal Distribution											
63			95% H-UCL		135.2							90% Chebyshev (MVUE) UCL 143.4
64			95% Chebyshev (MVUE) UCL		156							97.5% Chebyshev (MVUE) UCL 173.5
65			99% Chebyshev (MVUE) UCL		207.9							
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data do not follow a Discernible Distribution (0.05)											
69												
70	Nonparametric Distribution Free UCLs											
71			95% CLT UCL		126.6							95% Jackknife UCL 127.3
72			95% Standard Bootstrap UCL		126.2							95% Bootstrap-t UCL 124.7
73			95% Hall's Bootstrap UCL		123.7							95% Percentile Bootstrap UCL 125.2
74			95% BCA Bootstrap UCL		124.4							
75			90% Chebyshev(Mean, Sd) UCL		136.3							95% Chebyshev(Mean, Sd) UCL 146
76			97.5% Chebyshev(Mean, Sd) UCL		159.6							99% Chebyshev(Mean, Sd) UCL 186.2
77												
78	Suggested UCL to Use											
79			95% Student's-t UCL		127.3							or 95% Modified-t UCL 126.9
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												
86	Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positively skewed data sets.											
87												
88												

ProUCL Output
South Percolation Pond Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L												
1	UCL Statistics for Data Sets with Non-Detects																							
2																								
3	User Selected Options																							
4	Date/Time of Computation	ProUCL 5.17/30/2018 10:04:57 AM																						
5	From File	20180727_fluoride_MISC_for_proucl.xls																						
6	Full Precision	OFF																						
7	Confidence Coefficient	95%																						
8	Number of Bootstrap Operations	2000																						
9																								
10																								
11	Fluoride																							
12																								
13	General Statistics																							
14	Total Number of Observations	23			Number of Distinct Observations		23																	
15					Number of Missing Observations		0																	
16	Minimum	1.8			Mean		14.19																	
17	Maximum	44.1			Median		14.4																	
18	SD	10.49			Std. Error of Mean		2.188																	
19	Coefficient of Variation	0.739			Skewness		1.066																	
20																								
21	Normal GOF Test																							
22	Shapiro Wilk Test Statistic	0.901	Shapiro Wilk GOF Test																					
23	5% Shapiro Wilk Critical Value	0.914	Data Not Normal at 5% Significance Level																					
24	Lilliefors Test Statistic	0.133	Lilliefors GOF Test																					
25	5% Lilliefors Critical Value	0.18	Data appear Normal at 5% Significance Level																					
26	Data appear Approximate Normal at 5% Significance Level																							
27																								
28	Assuming Normal Distribution																							
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																			
30	95% Student's-t UCL				17.95		95% Adjusted-CLT UCL (Chen-1995)		18.31															
31							95% Modified-t UCL (Johnson-1978)		18.03															
32																								
33	Gamma GOF Test																							
34	A-D Test Statistic	0.652	Anderson-Darling Gamma GOF Test																					
35	5% A-D Critical Value	0.758	Detected data appear Gamma Distributed at 5% Significance Level																					
36	K-S Test Statistic	0.185	Kolmogorov-Smirnov Gamma GOF Test																					
37	5% K-S Critical Value	0.185	Data Not Gamma Distributed at 5% Significance Level																					
38	Detected data follow Appr. Gamma Distribution at 5% Significance Level																							
39																								
40	Gamma Statistics																							
41	k hat (MLE)	1.671	k star (bias corrected MLE)		1.482																			
42	Theta hat (MLE)	8.491	Theta star (bias corrected MLE)		9.574																			
43	nu hat (MLE)	76.89	nu star (bias corrected)		68.19																			
44	MLE Mean (bias corrected)	14.19	MLE Sd (bias corrected)		11.66																			
45					Approximate Chi Square Value (0.05)		50.19																	
46	Adjusted Level of Significance	0.0389	Adjusted Chi Square Value		49.07																			
47																								
48	Assuming Gamma Distribution																							
49	95% Approximate Gamma UCL (use when n>=50))	19.29	95% Adjusted Gamma UCL (use when n<50)		19.73																			
50																								

ProUCL Output
South Percolation Pond Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L
51	Lognormal GOF Test											
52			Shapiro Wilk Test Statistic		0.914							Shapiro Wilk Lognormal GOF Test
53			5% Shapiro Wilk Critical Value		0.914							Data Not Lognormal at 5% Significance Level
54			Lilliefors Test Statistic		0.233							Lilliefors Lognormal GOF Test
55			5% Lilliefors Critical Value		0.18							Data Not Lognormal at 5% Significance Level
56	Data Not Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59			Minimum of Logged Data		0.588							Mean of logged Data 2.325
60			Maximum of Logged Data		3.786							SD of logged Data 0.911
61												
62	Assuming Lognormal Distribution											
63			95% H-UCL		24.74							90% Chebyshev (MVUE) UCL 24.69
64			95% Chebyshev (MVUE) UCL		29.03							97.5% Chebyshev (MVUE) UCL 35.05
65			99% Chebyshev (MVUE) UCL		46.88							
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71			95% CLT UCL		17.79							95% Jackknife UCL 17.95
72			95% Standard Bootstrap UCL		17.67							95% Bootstrap-t UCL 18.53
73			95% Hall's Bootstrap UCL		19.17							95% Percentile Bootstrap UCL 17.77
74			95% BCA Bootstrap UCL		18.08							
75			90% Chebyshev(Mean, Sd) UCL		20.76							95% Chebyshev(Mean, Sd) UCL 23.73
76			97.5% Chebyshev(Mean, Sd) UCL		27.86							99% Chebyshev(Mean, Sd) UCL 35.96
77												
78	Suggested UCL to Use											
79			95% Student's-t UCL		17.95							
80												
81	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
82	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL.											
83												
84	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
85	Recommendations are based upon data size, data distribution, and skewness.											
86	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
87	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
88												

ProUCL Output
South Percolation Pond Area Soil (0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L															
1	UCL Statistics for Data Sets with Non-Detects																										
2																											
3	User Selected Options																										
4	Date/Time of Computation	ProUCL 5.17/30/2018 10:04:11 AM																									
5	From File	20180727_fluoride_MISC_for_proucl_a.xls																									
6	Full Precision	OFF																									
7	Confidence Coefficient	95%																									
8	Number of Bootstrap Operations	2000																									
9																											
10																											
11	Fluoride																										
12																											
13	General Statistics																										
14	Total Number of Observations	47			Number of Distinct Observations		44																				
15					Number of Missing Observations		0																				
16	Minimum	1.26			Mean		13.59																				
17	Maximum	44.1			Median		14.3																				
18	SD	8.979			Std. Error of Mean		1.31																				
19	Coefficient of Variation	0.661			Skewness		0.913																				
20																											
21	Normal GOF Test																										
22	Shapiro Wilk Test Statistic	0.922	Shapiro Wilk GOF Test																								
23	5% Shapiro Wilk Critical Value	0.946	Data Not Normal at 5% Significance Level																								
24	Lilliefors Test Statistic	0.128	Lilliefors GOF Test																								
25	5% Lilliefors Critical Value	0.128	Data appear Normal at 5% Significance Level																								
26	Data appear Approximate Normal at 5% Significance Level																										
27																											
28	Assuming Normal Distribution																										
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																						
30	95% Student's-t UCL				15.79	95% Adjusted-CLT UCL (Chen-1995)		15.93																			
31						95% Modified-t UCL (Johnson-1978)		15.82																			
32																											
33	Gamma GOF Test																										
34	A-D Test Statistic	1.456	Anderson-Darling Gamma GOF Test																								
35	5% A-D Critical Value	0.764	Data Not Gamma Distributed at 5% Significance Level																								
36	K-S Test Statistic	0.165	Kolmogorov-Smirnov Gamma GOF Test																								
37	5% K-S Critical Value	0.131	Data Not Gamma Distributed at 5% Significance Level																								
38	Data Not Gamma Distributed at 5% Significance Level																										
39																											
40	Gamma Statistics																										
41	k hat (MLE)	1.817	k star (bias corrected MLE)		1.715																						
42	Theta hat (MLE)	7.479	Theta star (bias corrected MLE)		7.922																						
43	nu hat (MLE)	170.8	nu star (bias corrected)		161.2																						
44	MLE Mean (bias corrected)	13.59	MLE Sd (bias corrected)		10.38																						
45					Approximate Chi Square Value (0.05)		132.9																				
46	Adjusted Level of Significance	0.0449			Adjusted Chi Square Value		132																				
47																											
48	Assuming Gamma Distribution																										
49	95% Approximate Gamma UCL (use when n>=50))	16.49	95% Adjusted Gamma UCL (use when n<50)		16.59																						
50																											

ProUCL Output
South Percolation Pond Area Soil (0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L
51	Lognormal GOF Test											
52			Shapiro Wilk Test Statistic		0.879							
53			5% Shapiro Wilk Critical Value		0.946							
54			Lilliefors Test Statistic		0.207							
55			5% Lilliefors Critical Value		0.128							
56	Data Not Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59			Minimum of Logged Data		0.231							Mean of logged Data 2.309
60			Maximum of Logged Data		3.786							SD of logged Data 0.897
61												
62	Assuming Lognormal Distribution											
63			95% H-UCL		20.2							90% Chebyshev (MVUE) UCL 21.56
64			95% Chebyshev (MVUE) UCL		24.58							97.5% Chebyshev (MVUE) UCL 28.78
65			99% Chebyshev (MVUE) UCL		37.03							
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71			95% CLT UCL		15.74							95% Jackknife UCL 15.79
72			95% Standard Bootstrap UCL		15.79							95% Bootstrap-t UCL 15.96
73			95% Hall's Bootstrap UCL		16							95% Percentile Bootstrap UCL 15.79
74			95% BCA Bootstrap UCL		16.11							
75			90% Chebyshev(Mean, Sd) UCL		17.52							95% Chebyshev(Mean, Sd) UCL 19.3
76			97.5% Chebyshev(Mean, Sd) UCL		21.77							99% Chebyshev(Mean, Sd) UCL 26.62
77												
78	Suggested UCL to Use											
79			95% Student's-t UCL		15.79							
80												
81	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
82	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL.											
83												
84	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
85	Recommendations are based upon data size, data distribution, and skewness.											
86	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
87	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
88												

ProUCL Output
South Percolation Pond Area (surface water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L									
1	UCL Statistics for Data Sets with Non-Detects																				
2																					
3	User Selected Options																				
4	Date/Time of Computation																				
5	From File																				
6	Full Precision																				
7	Confidence Coefficient																				
8	Number of Bootstrap Operations																				
9																					
10	Fluoride																				
11																					
12	General Statistics																				
13	Total Number of Observations			17	Number of Distinct Observations			17													
14					Number of Missing Observations			0													
15	Minimum			250					Mean			1447									
16	Maximum			9240					Median			379									
17	SD			2248					Std. Error of Mean			545.2									
18	Coefficient of Variation			1.554					Skewness			2.931									
19																					
20	Normal GOF Test																				
21	Shapiro Wilk Test Statistic			0.582	Shapiro Wilk GOF Test																
22	5% Shapiro Wilk Critical Value			0.892	Data Not Normal at 5% Significance Level																
23	Lilliefors Test Statistic			0.314	Lilliefors GOF Test																
24	5% Lilliefors Critical Value			0.207	Data Not Normal at 5% Significance Level																
25	Data Not Normal at 5% Significance Level																				
26																					
27	Assuming Normal Distribution																				
28	95% Normal UCL				95% UCLs (Adjusted for Skewness)																
29	95% Student's-t UCL				2399	95% Adjusted-CLT UCL (Chen-1995) 2758															
30						95% Modified-t UCL (Johnson-1978) 2463															
31																					
32	Gamma GOF Test																				
33	A-D Test Statistic			1.655	Anderson-Darling Gamma GOF Test																
34	5% A-D Critical Value			0.773	Data Not Gamma Distributed at 5% Significance Level																
35	K-S Test Statistic			0.299	Kolmogorov-Smirnov Gamma GOF Test																
36	5% K-S Critical Value			0.216	Data Not Gamma Distributed at 5% Significance Level																
37	Data Not Gamma Distributed at 5% Significance Level																				
38																					
39	Gamma Statistics																				
40	k hat (MLE)			0.842	k star (bias corrected MLE)			0.732													
41	Theta hat (MLE)			1719	Theta star (bias corrected MLE)			1975													
42	nu hat (MLE)			28.62	nu star (bias corrected)			24.9													
43	MLE Mean (bias corrected)			1447	MLE Sd (bias corrected)			1691													
44					Approximate Chi Square Value (0.05)			14.54													
45	Adjusted Level of Significance			0.0346	Adjusted Chi Square Value			13.71													
46																					
47	Assuming Gamma Distribution																				
48	95% Approximate Gamma UCL (use when n>=50)			2478	95% Adjusted Gamma UCL (use when n<50)			2628													
49																					

ProUCL Output
South Percolation Pond Area (surface water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L
50	Lognormal GOF Test											
51				Shapiro Wilk Test Statistic	0.828							
52				5% Shapiro Wilk Critical Value	0.892							
53				Lilliefors Test Statistic	0.276							
54				5% Lilliefors Critical Value	0.207							
55	Data Not Lognormal at 5% Significance Level											
56												
57	Lognormal Statistics											
58				Minimum of Logged Data	5.521							Mean of logged Data 6.577
59				Maximum of Logged Data	9.131							SD of logged Data 1.104
60												
61	Assuming Lognormal Distribution											
62				95% H-UCL	2880							90% Chebyshev (MVUE) UCL 2378
63				95% Chebyshev (MVUE) UCL	2888							97.5% Chebyshev (MVUE) UCL 3596
64				99% Chebyshev (MVUE) UCL	4986							
65												
66	Nonparametric Distribution Free UCL Statistics											
67	Data do not follow a Discernible Distribution (0.05)											
68												
69	Nonparametric Distribution Free UCLs											
70				95% CLT UCL	2344							95% Jackknife UCL 2399
71				95% Standard Bootstrap UCL	2305							95% Bootstrap-t UCL 3732
72				95% Hall's Bootstrap UCL	5431							95% Percentile Bootstrap UCL 2409
73				95% BCA Bootstrap UCL	2852							
74				90% Chebyshev(Mean, Sd) UCL	3083							95% Chebyshev(Mean, Sd) UCL 3823
75				97.5% Chebyshev(Mean, Sd) UCL	4852							99% Chebyshev(Mean, Sd) UCL 6872
76												
77	Suggested UCL to Use											
78				95% Chebyshev (Mean, Sd) UCL	3823							
79												
80	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
81	Recommendations are based upon data size, data distribution, and skewness.											
82	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
83	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
84												

ProUCL Output
South Percolation Pond Area (sediment)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L											
1	UCL Statistics for Data Sets with Non-Detects																						
2																							
3	User Selected Options																						
4	Date/Time of Computation	ProUCL 5.17/26/2018 2:34:48 PM																					
5																							
6	From File	WorkSheet.xls																					
7	Full Precision	OFF																					
8	Confidence Coefficient	95%																					
9	Number of Bootstrap Operations	2000																					
10																							
11	Fluoride																						
12																							
13	General Statistics																						
14	Total Number of Observations	11			Number of Distinct Observations		11																
15					Number of Missing Observations		0																
16	Minimum	5.3			Mean		48.56																
17	Maximum	195			Median		22.6																
18	SD	55.27			Std. Error of Mean		16.66																
19	Coefficient of Variation	1.138			Skewness		2.204																
20																							
21	Normal GOF Test																						
22	Shapiro Wilk Test Statistic	0.703	Shapiro Wilk GOF Test																				
23	5% Shapiro Wilk Critical Value	0.85	Data Not Normal at 5% Significance Level																				
24	Lilliefors Test Statistic	0.325	Lilliefors GOF Test																				
25	5% Lilliefors Critical Value	0.251	Data Not Normal at 5% Significance Level																				
26	Data Not Normal at 5% Significance Level																						
27																							
28	Assuming Normal Distribution																						
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																		
30	95% Student's-t UCL				78.77	95% Adjusted-CLT UCL (Chen-1995)		87.81															
31						95% Modified-t UCL (Johnson-1978)		80.61															
32																							
33	Gamma GOF Test																						
34	A-D Test Statistic	0.674	Anderson-Darling Gamma GOF Test																				
35	5% A-D Critical Value	0.747	Detected data appear Gamma Distributed at 5% Significance Level																				
36	K-S Test Statistic	0.244	Kolmogorov-Smirnov Gamma GOF Test																				
37	5% K-S Critical Value	0.261	Detected data appear Gamma Distributed at 5% Significance Level																				
38	Detected data appear Gamma Distributed at 5% Significance Level																						
39																							
40	Gamma Statistics																						
41	k hat (MLE)	1.252	k star (bias corrected MLE)		0.972																		
42	Theta hat (MLE)	38.77	Theta star (bias corrected MLE)		49.99																		
43	nu hat (MLE)	27.55	nu star (bias corrected)		21.37																		
44	MLE Mean (bias corrected)	48.56	MLE Sd (bias corrected)		49.27																		
45					Approximate Chi Square Value (0.05)		11.87																
46	Adjusted Level of Significance	0.0278			Adjusted Chi Square Value		10.73																
47																							
48	Assuming Gamma Distribution																						
49	95% Approximate Gamma UCL (use when n>=50)	87.45	95% Adjusted Gamma UCL (use when n<50)		96.72																		
50																							

ProUCL Output
South Percolation Pond Area (sediment)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L
51	Lognormal GOF Test											
52			Shapiro Wilk Test Statistic		0.94							
53			5% Shapiro Wilk Critical Value		0.85							
54			Lilliefors Test Statistic		0.182							
55			5% Lilliefors Critical Value		0.251							
56	Data appear Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59			Minimum of Logged Data		1.668							Mean of logged Data 3.433
60			Maximum of Logged Data		5.273							SD of logged Data 0.972
61												
62	Assuming Lognormal Distribution											
63			95% H-UCL		122.9							90% Chebyshev (MVUE) UCL 90.58
64			95% Chebyshev (MVUE) UCL		110.4							97.5% Chebyshev (MVUE) UCL 137.8
65			99% Chebyshev (MVUE) UCL		191.7							
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71			95% CLT UCL		75.97							95% Jackknife UCL 78.77
72			95% Standard Bootstrap UCL		74.26							95% Bootstrap-t UCL 118.5
73			95% Hall's Bootstrap UCL		164.2							95% Percentile Bootstrap UCL 76.29
74			95% BCA Bootstrap UCL		89.78							
75			90% Chebyshev(Mean, Sd) UCL		98.56							95% Chebyshev(Mean, Sd) UCL 121.2
76			97.5% Chebyshev(Mean, Sd) UCL		152.6							99% Chebyshev(Mean, Sd) UCL 214.4
77												
78	Suggested UCL to Use											
79			95% Adjusted Gamma UCL		96.72							
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												

ProUCL Output
Flathead River Area (surface water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L																				
1	UCL Statistics for Data Sets with Non-Detects																															
2																																
3	User Selected Options																															
4	Date/Time of Computation	ProUCL 5.17/17/2018 4:43:39 PM																														
5	From File	20180717_fluoride_for_proucl.xls																														
6	Full Precision	OFF																														
7	Confidence Coefficient	95%																														
8	Number of Bootstrap Operations	2000																														
9																																
10																																
11	Fluoride																															
12																																
13	General Statistics																															
14	Total Number of Observations	22		Number of Distinct Observations		21																										
15				Number of Missing Observations		0																										
16	Minimum	33.5				Mean		220.2																								
17	Maximum	2160				Median		112																								
18	SD	447.5				Std. Error of Mean		95.41																								
19	Coefficient of Variation	2.033				Skewness		4.258																								
20																																
21	Normal GOF Test																															
22	Shapiro Wilk Test Statistic	0.385		Shapiro Wilk GOF Test																												
23	5% Shapiro Wilk Critical Value	0.911		Data Not Normal at 5% Significance Level																												
24	Lilliefors Test Statistic	0.403		Lilliefors GOF Test																												
25	5% Lilliefors Critical Value	0.184		Data Not Normal at 5% Significance Level																												
26	Data Not Normal at 5% Significance Level																															
27																																
28	Assuming Normal Distribution																															
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																											
30	95% Student's-t UCL				95% Adjusted-CLT UCL (Chen-1995) 469.6																											
31					95% Modified-t UCL (Johnson-1978) 398.8																											
32																																
33	Gamma GOF Test																															
34	A-D Test Statistic	2.564		Anderson-Darling Gamma GOF Test																												
35	5% A-D Critical Value	0.777		Data Not Gamma Distributed at 5% Significance Level																												
36	K-S Test Statistic	0.366		Kolmogorov-Smirnov Gamma GOF Test																												
37	5% K-S Critical Value	0.192		Data Not Gamma Distributed at 5% Significance Level																												
38	Data Not Gamma Distributed at 5% Significance Level																															
39																																
40	Gamma Statistics																															
41	k hat (MLE)	0.879		k star (bias corrected MLE)		0.789																										
42	Theta hat (MLE)	250.5		Theta star (bias corrected MLE)		278.9																										
43	nu hat (MLE)	38.67		nu star (bias corrected)		34.73																										
44	MLE Mean (bias corrected)	220.2		MLE Sd (bias corrected)		247.8																										
45					Approximate Chi Square Value (0.05) 22.25																											
46	Adjusted Level of Significance	0.0386				Adjusted Chi Square Value		21.5																								
47																																
48	Assuming Gamma Distribution																															
49	95% Approximate Gamma UCL (use when n>=50))	343.7		95% Adjusted Gamma UCL (use when n<50))		355.6																										
50																																
51	Lognormal GOF Test																															

ProUCL Output
Flathead River Area (surface water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L
52					Shapiro Wilk Test Statistic	0.838						Shapiro Wilk Lognormal GOF Test
53					5% Shapiro Wilk Critical Value	0.911						Data Not Lognormal at 5% Significance Level
54					Lilliefors Test Statistic	0.28						Lilliefors Lognormal GOF Test
55					5% Lilliefors Critical Value	0.184						Data Not Lognormal at 5% Significance Level
56												Data Not Lognormal at 5% Significance Level
57												
58												Lognormal Statistics
59					Minimum of Logged Data	3.512						Mean of logged Data 4.727
60					Maximum of Logged Data	7.678						SD of logged Data 0.965
61												
62												Assuming Lognormal Distribution
63					95% H-UCL	307.1						90% Chebyshev (MVUE) UCL 295.7
64					95% Chebyshev (MVUE) UCL	350.4						97.5% Chebyshev (MVUE) UCL 426.4
65					99% Chebyshev (MVUE) UCL	575.7						
66												
67												Nonparametric Distribution Free UCL Statistics
68												Data do not follow a Discernible Distribution (0.05)
69												
70												Nonparametric Distribution Free UCLs
71					95% CLT UCL	377.1						95% Jackknife UCL 384.3
72					95% Standard Bootstrap UCL	373.5						95% Bootstrap-t UCL 1055
73					95% Hall's Bootstrap UCL	943.7						95% Percentile Bootstrap UCL 399.8
74					95% BCA Bootstrap UCL	527						
75					90% Chebyshev(Mean, Sd) UCL	506.4						95% Chebyshev(Mean, Sd) UCL 636
76					97.5% Chebyshev(Mean, Sd) UCL	816						99% Chebyshev(Mean, Sd) UCL 1169
77												
78												Suggested UCL to Use
79					95% Chebyshev (Mean, Sd) UCL	636						
80												
81												Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
82												Recommendations are based upon data size, data distribution, and skewness.
83												These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
84												However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.
85												

ProUCL Output
Backwater Seep Area Soil (0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L																
1	UCL Statistics for Data Sets with Non-Detects																											
2																												
3	User Selected Options																											
4	Date/Time of Computation	ProUCL 5.17/30/2018 9:57:04 AM																										
5	From File	20180727_fluoride_MISC_for_proucl_b.xls																										
6	Full Precision	OFF																										
7	Confidence Coefficient	95%																										
8	Number of Bootstrap Operations	2000																										
9																												
10																												
11	Fluoride																											
12																												
13	General Statistics																											
14	Total Number of Observations	14			Number of Distinct Observations	14																						
15					Number of Missing Observations	0																						
16	Minimum	1.58			Mean	19.14																						
17	Maximum	33.5			Median	16.85																						
18	SD	8.243			Std. Error of Mean	2.203																						
19	Coefficient of Variation	0.431			Skewness	-0.0178																						
20																												
21	Normal GOF Test																											
22	Shapiro Wilk Test Statistic	0.939	Shapiro Wilk GOF Test																									
23	5% Shapiro Wilk Critical Value	0.874	Data appear Normal at 5% Significance Level																									
24	Lilliefors Test Statistic	0.174	Lilliefors GOF Test																									
25	5% Lilliefors Critical Value	0.226	Data appear Normal at 5% Significance Level																									
26	Data appear Normal at 5% Significance Level																											
27																												
28	Assuming Normal Distribution																											
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																							
30	95% Student's-t UCL	23.04			95% Adjusted-CLT UCL (Chen-1995)	22.75																						
31					95% Modified-t UCL (Johnson-1978)	23.04																						
32																												
33	Gamma GOF Test																											
34	A-D Test Statistic	0.932	Anderson-Darling Gamma GOF Test																									
35	5% A-D Critical Value	0.742	Data Not Gamma Distributed at 5% Significance Level																									
36	K-S Test Statistic	0.241	Kolmogorov-Smirnov Gamma GOF Test																									
37	5% K-S Critical Value	0.23	Data Not Gamma Distributed at 5% Significance Level																									
38	Data Not Gamma Distributed at 5% Significance Level																											
39																												
40	Gamma Statistics																											
41	k hat (MLE)	3.326			Theta star (bias corrected MLE)	2.661																						
42	Theta hat (MLE)	5.756			Theta star (bias corrected MLE)	7.194																						
43	nu hat (MLE)	93.12			nu star (bias corrected)	74.5																						
44	MLE Mean (bias corrected)	19.14			MLE Sd (bias corrected)	11.73																						
45					Approximate Chi Square Value (0.05)	55.62																						
46	Adjusted Level of Significance	0.0312			Adjusted Chi Square Value	53.46																						
47																												
48	Assuming Gamma Distribution																											
49	95% Approximate Gamma UCL (use when n>=50))	25.64			95% Adjusted Gamma UCL (use when n<50)	26.67																						
50																												

**ProUCL Output
Backwater Seep Area Soil (0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana**

ProUCL Output
Backwater Seep Area (surface water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L								
1	UCL Statistics for Data Sets with Non-Detects																			
2																				
3	User Selected Options																			
4	Date/Time of Computation ProUCL 5.13/20/2018 6:37:58 AM																			
5	From File 20180319_ProUCL_inputRev_2_d.xls																			
6	Full Precision OFF																			
7	Confidence Coefficient 95%																			
8	Number of Bootstrap Operations 2000																			
9																				
10	Fluoride																			
11																				
12	General Statistics																			
13	Total Number of Observations 18				Number of Distinct Observations 18															
14					Number of Missing Observations 0															
15	Minimum 175				Mean 1141															
16	Maximum 2640				Median 585															
17	SD 1029				Std. Error of Mean 242.5															
18	Coefficient of Variation 0.902				Skewness 0.532															
19																				
20	Normal GOF Test																			
21	Shapiro Wilk Test Statistic 0.771				Shapiro Wilk GOF Test															
22	5% Shapiro Wilk Critical Value 0.897				Data Not Normal at 5% Significance Level															
23	Lilliefors Test Statistic 0.296				Lilliefors GOF Test															
24	5% Lilliefors Critical Value 0.202				Data Not Normal at 5% Significance Level															
25	Data Not Normal at 5% Significance Level																			
26																				
27	Assuming Normal Distribution																			
28	95% Normal UCL				95% UCLs (Adjusted for Skewness)															
29	95% Student's-t UCL 1563				95% Adjusted-CLT UCL (Chen-1995) 1573															
30					95% Modified-t UCL (Johnson-1978) 1568															
31																				
32	Gamma GOF Test																			
33	A-D Test Statistic 1.25				Anderson-Darling Gamma GOF Test															
34	5% A-D Critical Value 0.763				Data Not Gamma Distributed at 5% Significance Level															
35	K-S Test Statistic 0.204				Kolmogorov-Smirnov Gamma GOF Test															
36	5% K-S Critical Value 0.209				Detected data appear Gamma Distributed at 5% Significance Level															
37	Detected data follow Appr. Gamma Distribution at 5% Significance Level																			
38																				
39	Gamma Statistics																			
40	k hat (MLE) 1.16				k star (bias corrected MLE) 1.004															
41	Theta hat (MLE) 983.5				Theta star (bias corrected MLE) 1137															
42	nu hat (MLE) 41.77				nu star (bias corrected) 36.15															
43	MLE Mean (bias corrected) 1141				MLE Sd (bias corrected) 1139															
44					Approximate Chi Square Value (0.05) 23.39															
45	Adjusted Level of Significance 0.0357				Adjusted Chi Square Value 22.4															
46																				
47	Assuming Gamma Distribution																			
48	95% Approximate Gamma UCL (use when n>=50) 1764				95% Adjusted Gamma UCL (use when n<50) 1841															
49																				

ProUCL Output
Backwater Seep Area (surface water)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L		
Lognormal GOF Test														
50														
51					Shapiro Wilk Test Statistic	0.853								
52					5% Shapiro Wilk Critical Value	0.897								
53					Lilliefors Test Statistic	0.202								
54					5% Lilliefors Critical Value	0.202								
55					Data Not Lognormal at 5% Significance Level									
56														
57					Lognormal Statistics									
58					Minimum of Logged Data	5.165					Mean of logged Data	6.551		
59					Maximum of Logged Data	7.879					SD of logged Data	1.069		
60														
61					Assuming Lognormal Distribution									
62					95% H-UCL	2519					90% Chebyshev (MVUE) UCL	2184		
63					95% Chebyshev (MVUE) UCL	2638					97.5% Chebyshev (MVUE) UCL	3267		
64					99% Chebyshev (MVUE) UCL	4504								
65														
66					Nonparametric Distribution Free UCL Statistics									
67					Data appear to follow a Discernible Distribution at 5% Significance Level									
68														
69					Nonparametric Distribution Free UCLs									
70					95% CLT UCL	1540					95% Jackknife UCL	1563		
71					95% Standard Bootstrap UCL	1526					95% Bootstrap-t UCL	1617		
72					95% Hall's Bootstrap UCL	1512					95% Percentile Bootstrap UCL	1529		
73					95% BCA Bootstrap UCL	1558								
74					90% Chebyshev(Mean, Sd) UCL	1869					95% Chebyshev(Mean, Sd) UCL	2198		
75					97.5% Chebyshev(Mean, Sd) UCL	2656					99% Chebyshev(Mean, Sd) UCL	3554		
76														
77					Suggested UCL to Use									
78					95% Adjusted Gamma UCL	1841								
79														
80					When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test									
81					When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL.									
82														
83					Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.									
84					Recommendations are based upon data size, data distribution, and skewness.									
85					These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).									
86					However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.									

ProUCL Output
Groundwater - Plume Area Upper Hydrogeologic Unit
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L											
1	UCL Statistics for Data Sets with Non-Detects																						
2																							
3	User Selected Options																						
4	Date/Time of Computation	ProUCL 5.17/27/2018 1:58:02 PM																					
5	From File	20180727_fluoride_GW_for_proucl.xls																					
6	Full Precision	OFF																					
7	Confidence Coefficient	95%																					
8	Number of Bootstrap Operations	2000																					
9																							
10	Fluoride																						
11																							
12	General Statistics																						
13	Total Number of Observations	116	Number of Distinct Observations																				
14	Number of Detects	115	Number of Non-Detects																				
15	Number of Distinct Detects	107	Number of Distinct Non-Detects																				
16	Minimum Detect	207	Minimum Non-Detect																				
17	Maximum Detect	52900	Maximum Non-Detect																				
18	Variance Detects	57073768	Percent Non-Detects																				
19	Mean Detects	4699	SD Detects																				
20	Median Detects	2550	CV Detects																				
21	Skewness Detects	4.022	Kurtosis Detects																				
22	Mean of Logged Detects	7.829	SD of Logged Detects																				
23																							
24	Normal GOF Test on Detects Only																						
25	Shapiro Wilk Test Statistic	0.519	Normal GOF Test on Detected Observations Only																				
26	5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level																				
27	Lilliefors Test Statistic	0.318	Lilliefors GOF Test																				
28	5% Lilliefors Critical Value	0.0829	Detected Data Not Normal at 5% Significance Level																				
29	Detected Data Not Normal at 5% Significance Level																						
30																							
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs																						
32	KM Mean	4659	KM Standard Error of Mean																				
33	KM SD	7502	95% KM (BCA) UCL																				
34	95% KM (t) UCL	5819	95% KM (Percentile Bootstrap) UCL																				
35	95% KM (z) UCL	5810	95% KM Bootstrap t UCL																				
36	90% KM Chebyshev UCL	6758	95% KM Chebyshev UCL																				
37	97.5% KM Chebyshev UCL	9028	99% KM Chebyshev UCL																				
38																							
39	Gamma GOF Tests on Detected Observations Only																						
40	A-D Test Statistic	6.351	Anderson-Darling GOF Test																				
41	5% A-D Critical Value	0.786	Detected Data Not Gamma Distributed at 5% Significance Level																				
42	K-S Test Statistic	0.215	Kolmogorov-Smirnov GOF																				
43	5% K-S Critical Value	0.0884	Detected Data Not Gamma Distributed at 5% Significance Level																				
44	Detected Data Not Gamma Distributed at 5% Significance Level																						
45																							
46	Gamma Statistics on Detected Data Only																						
47	k hat (MLE)	0.93	k star (bias corrected MLE)																				
48	Theta hat (MLE)	5053	Theta star (bias corrected MLE)																				
49	nu hat (MLE)	213.9	nu star (bias corrected)																				
50	Mean (detects)	4699																					
51																							

ProUCL Output
Groundwater - Plume Area Upper Hydrogeologic Unit
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L											
52	Gamma ROS Statistics using Imputed Non-Detects																						
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs																						
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)																						
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs																						
56	This is especially true when the sample size is small.																						
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates																						
58		Minimum	0.01							Mean	4659												
59		Maximum	52900							Median	2520												
60		SD	7534							CV	1.617												
61		k hat (MLE)	0.817							k star (bias corrected MLE)	0.801												
62		Theta hat (MLE)	5704							Theta star (bias corrected MLE)	5813												
63		nu hat (MLE)	189.5							nu star (bias corrected)	185.9												
64		Adjusted Level of Significance (β)	0.0479																				
65		Approximate Chi Square Value (185.92, α)	155.4							Adjusted Chi Square Value (185.92, β)	155												
66		95% Gamma Approximate UCL (use when n>=50)	5574							95% Gamma Adjusted UCL (use when n<50)	5587												
67																							
68	Estimates of Gamma Parameters using KM Estimates																						
69		Mean (KM)	4659							SD (KM)	7502												
70		Variance (KM)	56273672							SE of Mean (KM)	699.6												
71		k hat (KM)	0.386							k star (KM)	0.382												
72		nu hat (KM)	89.5							nu star (KM)	88.51												
73		theta hat (KM)	12078							theta star (KM)	12212												
74		80% gamma percentile (KM)	7475							90% gamma percentile (KM)	13268												
75		95% gamma percentile (KM)	19676							99% gamma percentile (KM)	35871												
76																							
77	Gamma Kaplan-Meier (KM) Statistics																						
78		Approximate Chi Square Value (88.51, α)	67.82							Adjusted Chi Square Value (88.51, β)	67.6												
79		95% Gamma Approximate KM-UCL (use when n>=50)	6081							95% Gamma Adjusted KM-UCL (use when n<50)	6101												
80																							
81	Lognormal GOF Test on Detected Observations Only																						
82		Shapiro Wilk Approximate Test Statistic	0.922							Shapiro Wilk GOF Test													
83		5% Shapiro Wilk P Value	2.3520E-7							Detected Data Not Lognormal at 5% Significance Level													
84		Lilliefors Test Statistic	0.167							Lilliefors GOF Test													
85		5% Lilliefors Critical Value	0.0829							Detected Data Not Lognormal at 5% Significance Level													
86		Detected Data Not Lognormal at 5% Significance Level																					
87																							
88	Lognormal ROS Statistics Using Imputed Non-Detects																						
89		Mean in Original Scale	4660							Mean in Log Scale	7.804												
90		SD in Original Scale	7534							SD in Log Scale	1.116												
91		95% t UCL (assumes normality of ROS data)	5820							95% Percentile Bootstrap UCL	5834												
92		95% BCA Bootstrap UCL	6147							95% Bootstrap t UCL	6497												
93		95% H-UCL (Log ROS)	5822																				
94																							
95	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution																						
96		KM Mean (logged)	7.797							KM Geo Mean	2433												
97		KM SD (logged)	1.132							95% Critical H Value (KM-Log)	2.346												
98		KM Standard Error of Mean (logged)	0.106							95% H-UCL (KM -Log)	5915												
99		KM SD (logged)	1.132							95% Critical H Value (KM-Log)	2.346												
100		KM Standard Error of Mean (logged)	0.106																				
101																							

ProUCL Output
Groundwater - Plume Area Upper Hydrogeologic Unit
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L												
102	DL/2 Statistics																							
103	DL/2 Normal							DL/2 Log-Transformed																
104	Mean in Original Scale				4659																			
105	SD in Original Scale				7534																			
106	95% t UCL (Assumes normality)				5819																			
107	DL/2 is not a recommended method, provided for comparisons and historical reasons																							
108																								
109	Nonparametric Distribution Free UCL Statistics																							
110	Data do not follow a Discernible Distribution at 5% Significance Level																							
111																								
112	Suggested UCL to Use																							
113	95% KM (Chebyshev) UCL				7708																			
114																								
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.																							
116	Recommendations are based upon data size, data distribution, and skewness.																							
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).																							
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.																							
119																								

ProUCL Output
Groundwater - Sitewide Below Upper Hydrogeologic Unit
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L											
1	UCL Statistics for Data Sets with Non-Detects																						
2																							
3	User Selected Options																						
4	Date/Time of Computation	ProUCL 5.17/27/2018 1:59:17 PM																					
5	From File	20180727_fluoride_GW_for_proucl_a.xls																					
6	Full Precision	OFF																					
7	Confidence Coefficient	95%																					
8	Number of Bootstrap Operations	2000																					
9																							
10	Fluoride																						
11																							
12	General Statistics																						
13	Total Number of Observations	52	Number of Distinct Observations																				
14	Number of Detects	50	Number of Non-Detects																				
15	Number of Distinct Detects	48	Number of Distinct Non-Detects																				
16	Minimum Detect	49	Minimum Non-Detect																				
17	Maximum Detect	569	Maximum Non-Detect																				
18	Variance Detects	17014	Percent Non-Detects																				
19	Mean Detects	249.5	SD Detects																				
20	Median Detects	202	CV Detects																				
21	Skewness Detects	0.766	Kurtosis Detects																				
22	Mean of Logged Detects	5.378	SD of Logged Detects																				
23																							
24	Normal GOF Test on Detects Only																						
25	Shapiro Wilk Test Statistic	0.919	Shapiro Wilk GOF Test																				
26	5% Shapiro Wilk Critical Value	0.947	Detected Data Not Normal at 5% Significance Level																				
27	Lilliefors Test Statistic	0.156	Lilliefors GOF Test																				
28	5% Lilliefors Critical Value	0.125	Detected Data Not Normal at 5% Significance Level																				
29	Detected Data Not Normal at 5% Significance Level																						
30																							
31	Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs																						
32	KM Mean	240.5	KM Standard Error of Mean																				
33	KM SD	134.4	95% KM (BCA) UCL																				
34	95% KM (t) UCL	272	95% KM (Percentile Bootstrap) UCL																				
35	95% KM (z) UCL	271.4	95% KM Bootstrap t UCL																				
36	90% KM Chebyshev UCL	297	95% KM Chebyshev UCL																				
37	97.5% KM Chebyshev UCL	358.1	99% KM Chebyshev UCL																				
38																							
39	Gamma GOF Tests on Detected Observations Only																						
40	A-D Test Statistic	0.525	Anderson-Darling GOF Test																				
41	5% A-D Critical Value	0.755	Detected data appear Gamma Distributed at 5% Significance Level																				
42	K-S Test Statistic	0.0979	Kolmogorov-Smirnov GOF																				
43	5% K-S Critical Value	0.126	Detected data appear Gamma Distributed at 5% Significance Level																				
44	Detected data appear Gamma Distributed at 5% Significance Level																						
45																							
46	Gamma Statistics on Detected Data Only																						
47	k hat (MLE)	3.686	k star (bias corrected MLE)																				
48	Theta hat (MLE)	67.69	Theta star (bias corrected MLE)																				
49	nu hat (MLE)	368.6	nu star (bias corrected)																				
50	Mean (detects)	249.5	347.8																				
51																							

ProUCL Output
Groundwater - Sitewide Below Upper Hydrogeologic Unit
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L								
52	Gamma ROS Statistics using Imputed Non-Detects																			
53	GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs																			
54	GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)																			
55	For such situations, GROS method may yield incorrect values of UCLs and BTVs																			
56	This is especially true when the sample size is small.																			
57	For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates																			
58																				
59	Minimum		25.56			Mean		241.2												
60	Maximum		569			Median		199												
61	SD		134.6			CV		0.558												
62	k hat (MLE)		2.912			k star (bias corrected MLE)		2.757												
63	Theta hat (MLE)		82.8			Theta star (bias corrected MLE)		87.46												
64	nu hat (MLE)		302.9			nu star (bias corrected)		286.7												
65	Adjusted Level of Significance (β)		0.0454																	
66	Approximate Chi Square Value (286.75, α)		248.5			Adjusted Chi Square Value (286.75, β)		247.5												
67	95% Gamma Approximate UCL (use when n>=50)		278.2			95% Gamma Adjusted UCL (use when n<50)		279.4												
68	Estimates of Gamma Parameters using KM Estimates																			
69	Mean (KM)		240.5			SD (KM)		134.4												
70	Variance (KM)		18065			SE of Mean (KM)		18.83												
71	k hat (KM)		3.201			k star (KM)		3.029												
72	nu hat (KM)		332.9			nu star (KM)		315												
73	theta hat (KM)		75.13			theta star (KM)		79.39												
74	80% gamma percentile (KM)		342.6			90% gamma percentile (KM)		425.7												
75	95% gamma percentile (KM)		503.3			99% gamma percentile (KM)		671.2												
76	Gamma Kaplan-Meier (KM) Statistics																			
77	Approximate Chi Square Value (315.02, α)		274.9			Adjusted Chi Square Value (315.02, β)		273.8												
78	95% Gamma Approximate KM-UCL (use when n>=50)		275.6			95% Gamma Adjusted KM-UCL (use when n<50)		276.6												
79	Lognormal GOF Test on Detected Observations Only																			
80																				
81	Shapiro Wilk Test Statistic		0.956			Shapiro Wilk GOF Test														
82	5% Shapiro Wilk Critical Value		0.947			Detected Data appear Lognormal at 5% Significance Level														
83	Lilliefors Test Statistic		0.0795			Lilliefors GOF Test														
84	5% Lilliefors Critical Value		0.125			Detected Data appear Lognormal at 5% Significance Level														
85	Detected Data appear Lognormal at 5% Significance Level																			
86																				
87	Lognormal ROS Statistics Using Imputed Non-Detects																			
88																				
89	Mean in Original Scale		242.1			Mean in Log Scale		5.326												
90	SD in Original Scale		133.2			SD in Log Scale		0.609												
91	95% t UCL (assumes normality of ROS data)		273			95% Percentile Bootstrap UCL		273.5												
92	95% BCA Bootstrap UCL		272.8			95% Bootstrap t UCL		275.4												
93	95% H-UCL (Log ROS)		292.2																	
94	Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution																			
95																				
96	KM Mean (logged)		5.275			KM Geo Mean		195.4												
97	KM SD (logged)		0.748			95% Critical H Value (KM-Log)		2.068												
98	KM Standard Error of Mean (logged)		0.105			95% H-UCL (KM -Log)		320.9												
99	KM SD (logged)		0.748			95% Critical H Value (KM-Log)		2.068												
100	KM Standard Error of Mean (logged)		0.105																	
101																				

ProUCL Output
Groundwater - Sitewide Below Upper Hydrogeologic Unit
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L								
102	DL/2 Statistics																			
103	DL/2 Normal																			
104	Mean in Original Scale							240.2	Mean in Log Scale											
105	SD in Original Scale							136.2	SD in Log Scale											
106	95% t UCL (Assumes normality)							271.8	95% H-Stat UCL											
107	DL/2 is not a recommended method, provided for comparisons and historical reasons																			
108																				
109	Nonparametric Distribution Free UCL Statistics																			
110	Detected Data appear Gamma Distributed at 5% Significance Level																			
111																				
112	Suggested UCL to Use																			
113	95% KM Approximate Gamma UCL				275.6	95% GROS Approximate Gamma UCL				278.2										
114																				
115	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.																			
116	Recommendations are based upon data size, data distribution, and skewness.																			
117	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).																			
118	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.																			
119																				

ProUCL Output
Main Plant Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L															
1	UCL Statistics for Data Sets with Non-Detects																										
2																											
3	User Selected Options																										
4	Date/Time of Computation	ProUCL 5.17/30/2018 8:30:09 AM																									
5	From File	20180727_fluoride_vegetated_MPA_NPerc_for_proud_e.xls																									
6	Full Precision	OFF																									
7	Confidence Coefficient	95%																									
8	Number of Bootstrap Operations	2000																									
9																											
10																											
11	Fluoride																										
12																											
13	General Statistics																										
14	Total Number of Observations	19		Number of Distinct Observations		19																					
15				Number of Missing Observations		0																					
16	Minimum	4.25				Mean		33.25																			
17	Maximum	93.3				Median		22.2																			
18	SD	26.73				Std. Error of Mean		6.133																			
19	Coefficient of Variation	0.804				Skewness		0.98																			
20																											
21	Normal GOF Test																										
22	Shapiro Wilk Test Statistic	0.883		Shapiro Wilk GOF Test																							
23	5% Shapiro Wilk Critical Value	0.901		Data Not Normal at 5% Significance Level																							
24	Lilliefors Test Statistic	0.187		Lilliefors GOF Test																							
25	5% Lilliefors Critical Value	0.197		Data appear Normal at 5% Significance Level																							
26	Data appear Approximate Normal at 5% Significance Level																										
27																											
28	Assuming Normal Distribution																										
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																						
30	95% Student's-t UCL				43.89		95% Adjusted-CLT UCL (Chen-1995)		44.81																		
31							95% Modified-t UCL (Johnson-1978)		44.12																		
32																											
33	Gamma GOF Test																										
34	A-D Test Statistic	0.242		Anderson-Darling Gamma GOF Test																							
35	5% A-D Critical Value	0.756		Detected data appear Gamma Distributed at 5% Significance Level																							
36	K-S Test Statistic	0.109		Kolmogorov-Smirnov Gamma GOF Test																							
37	5% K-S Critical Value	0.202		Detected data appear Gamma Distributed at 5% Significance Level																							
38	Detected data appear Gamma Distributed at 5% Significance Level																										
39																											
40	Gamma Statistics																										
41	k hat (MLE)	1.614		k star (bias corrected MLE)		1.394																					
42	Theta hat (MLE)	20.6		Theta star (bias corrected MLE)		23.85																					
43	nu hat (MLE)	61.33		nu star (bias corrected)		52.98																					
44	MLE Mean (bias corrected)	33.25		MLE Sd (bias corrected)		28.16																					
45							Approximate Chi Square Value (0.05)		37.26																		
46	Adjusted Level of Significance	0.0369				Adjusted Chi Square Value		36.11																			
47																											
48	Assuming Gamma Distribution																										
49	95% Approximate Gamma UCL (use when n>=50))	47.28		95% Adjusted Gamma UCL (use when n<50))		48.79																					
50																											

ProUCL Output
Main Plant Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L
51	Lognormal GOF Test											
52			Shapiro Wilk Test Statistic		0.972							
53			5% Shapiro Wilk Critical Value		0.901							
54			Lilliefors Test Statistic		0.0933							
55			5% Lilliefors Critical Value		0.197							
56	Data appear Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59			Minimum of Logged Data		1.447							Mean of logged Data 3.163
60			Maximum of Logged Data		4.536							SD of logged Data 0.894
61												
62	Assuming Lognormal Distribution											
63			95% H-UCL		59.23							90% Chebyshev (MVUE) UCL 57.42
64			95% Chebyshev (MVUE) UCL		67.89							97.5% Chebyshev (MVUE) UCL 82.43
65			99% Chebyshev (MVUE) UCL		111							
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71			95% CLT UCL		43.34							95% Jackknife UCL 43.89
72			95% Standard Bootstrap UCL		42.86							95% Bootstrap-t UCL 45.56
73			95% Hall's Bootstrap UCL		44.08							95% Percentile Bootstrap UCL 43.2
74			95% BCA Bootstrap UCL		44.14							
75			90% Chebyshev(Mean, Sd) UCL		51.65							95% Chebyshev(Mean, Sd) UCL 59.98
76			97.5% Chebyshev(Mean, Sd) UCL		71.55							99% Chebyshev(Mean, Sd) UCL 94.27
77												
78	Suggested UCL to Use											
79			95% Student's-t UCL		43.89							
80												
81	When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test											
82	When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL.											
83												
84	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
85	Recommendations are based upon data size, data distribution, and skewness.											
86	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
87	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
88												

ProUCL Output
Main Plant ISS Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L													
1	UCL Statistics for Data Sets with Non-Detects																								
2																									
3	User Selected Options																								
4	Date/Time of Computation	ProUCL 5.17/30/2018 9:43:05 AM																							
5	From File	20180727_fluoride_ISS_for_proucl.xls																							
6	Full Precision	OFF																							
7	Confidence Coefficient	95%																							
8	Number of Bootstrap Operations	2000																							
9																									
10																									
11	Fluoride																								
12																									
13	General Statistics																								
14	Total Number of Observations	20			Number of Distinct Observations		20																		
15					Number of Missing Observations		0																		
16	Minimum	39.9					Mean		285.5																
17	Maximum	632					Median		257																
18	SD	218.7					Std. Error of Mean		48.91																
19	Coefficient of Variation	0.766					Skewness		0.375																
20																									
21	Normal GOF Test																								
22	Shapiro Wilk Test Statistic	0.866			Shapiro Wilk GOF Test																				
23	5% Shapiro Wilk Critical Value	0.905			Data Not Normal at 5% Significance Level																				
24	Lilliefors Test Statistic	0.211			Lilliefors GOF Test																				
25	5% Lilliefors Critical Value	0.192			Data Not Normal at 5% Significance Level																				
26	Data Not Normal at 5% Significance Level																								
27																									
28	Assuming Normal Distribution																								
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																				
30	95% Student's-t UCL				370.1			95% Adjusted-CLT UCL (Chen-1995)		370.4															
31								95% Modified-t UCL (Johnson-1978)		370.8															
32																									
33	Gamma GOF Test																								
34	A-D Test Statistic	0.878			Anderson-Darling Gamma GOF Test																				
35	5% A-D Critical Value	0.759			Data Not Gamma Distributed at 5% Significance Level																				
36	K-S Test Statistic	0.201			Kolmogorov-Smirnov Gamma GOF Test																				
37	5% K-S Critical Value	0.198			Data Not Gamma Distributed at 5% Significance Level																				
38	Data Not Gamma Distributed at 5% Significance Level																								
39																									
40	Gamma Statistics																								
41	k hat (MLE)	1.453					k star (bias corrected MLE)		1.268																
42	Theta hat (MLE)	196.6					Theta star (bias corrected MLE)		225.2																
43	nu hat (MLE)	58.1					nu star (bias corrected)		50.72																
44	MLE Mean (bias corrected)	285.5					MLE Sd (bias corrected)		253.6																
45							Approximate Chi Square Value (0.05)		35.36																
46	Adjusted Level of Significance	0.038					Adjusted Chi Square Value		34.35																
47																									
48	Assuming Gamma Distribution																								
49	95% Approximate Gamma UCL (use when n>=50))	409.5			95% Adjusted Gamma UCL (use when n<50)		421.6																		
50																									

ProUCL Output
Main Plant ISS Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L
51	Lognormal GOF Test											
52			Shapiro Wilk Test Statistic		0.882							
53			5% Shapiro Wilk Critical Value		0.905							
54			Lilliefors Test Statistic		0.177							
55			5% Lilliefors Critical Value		0.192							
56	Data appear Approximate Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59			Minimum of Logged Data		3.686							Mean of logged Data 5.272
60			Maximum of Logged Data		6.449							SD of logged Data 0.972
61												
62	Assuming Lognormal Distribution											
63			95% H-UCL		557.4							90% Chebyshev (MVUE) UCL 522.3
64			95% Chebyshev (MVUE) UCL		621.8							97.5% Chebyshev (MVUE) UCL 760
65			99% Chebyshev (MVUE) UCL		1031							
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71			95% CLT UCL		366							95% Jackknife UCL 370.1
72			95% Standard Bootstrap UCL		364.5							95% Bootstrap-t UCL 377.1
73			95% Hall's Bootstrap UCL		365.7							95% Percentile Bootstrap UCL 364.6
74			95% BCA Bootstrap UCL		368							
75			90% Chebyshev(Mean, Sd) UCL		432.3							95% Chebyshev(Mean, Sd) UCL 498.7
76			97.5% Chebyshev(Mean, Sd) UCL		590.9							99% Chebyshev(Mean, Sd) UCL 772.1
77												
78	Suggested UCL to Use											
79			95% H-UCL		557.4							
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												
86	ProUCL computes and outputs H-statistic based UCLs for historical reasons only.											
87	H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.											
88	It is therefore recommended to avoid the use of H-statistic based 95% UCLs.											
89	Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.											
90												

ProUCL Output
 Main Plant ISS Area Soil (0-2 ft-bgs)
 Columbia Falls Aluminum Facility
 Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L																		
1	UCL Statistics for Data Sets with Non-Detects																													
2																														
3	User Selected Options																													
4	Date/Time of Computation	ProUCL 5.18/21/2018 10:30:10 AM																												
5	From File	WorkSheet.xls																												
6	Full Precision	OFF																												
7	Confidence Coefficient	95%																												
8	Number of Bootstrap Operations	2000																												
9																														
10																														
11	Fluoride																													
12																														
13	General Statistics																													
14	Total Number of Observations	41	Number of Distinct Observations																											
15			Number of Missing Observations																											
16	Minimum	39.9	Mean																											
17	Maximum	946	Median																											
18	SD	244.7	Std. Error of Mean																											
19	Coefficient of Variation	0.82	Skewness																											
20																														
21	Normal GOF Test																													
22	Shapiro Wilk Test Statistic	0.865	Shapiro Wilk GOF Test																											
23	5% Shapiro Wilk Critical Value	0.941	Data Not Normal at 5% Significance Level																											
24	Lilliefors Test Statistic	0.173	Lilliefors GOF Test																											
25	5% Lilliefors Critical Value	0.137	Data Not Normal at 5% Significance Level																											
26	Data Not Normal at 5% Significance Level																													
27																														
28	Assuming Normal Distribution																													
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																									
30	95% Student's-t UCL	362.7	95% Adjusted-CLT UCL (Chen-1995)																											
31			95% Modified-t UCL (Johnson-1978)																											
32	Gamma GOF Test																													
33	A-D Test Statistic	0.84	Anderson-Darling Gamma GOF Test																											
34	5% A-D Critical Value	0.766	Data Not Gamma Distributed at 5% Significance Level																											
35	K-S Test Statistic	0.145	Kolmogorov-Smirnov Gamma GOF Test																											
36	5% K-S Critical Value	0.14	Data Not Gamma Distributed at 5% Significance Level																											
37	Data Not Gamma Distributed at 5% Significance Level																													
38																														
39	Gamma Statistics																													
40	k hat (MLE)	1.515	k star (bias corrected MLE)																											
41	Theta hat (MLE)	197	Theta star (bias corrected MLE)																											
42	nu hat (MLE)	124.2	nu star (bias corrected)																											
43	MLE Mean (bias corrected)	298.3	MLE Sd (bias corrected)																											
44			Approximate Chi Square Value (0.05)																											
45	Adjusted Level of Significance	0.0441	Adjusted Chi Square Value																											
46			91.75																											
47	Assuming Gamma Distribution																													
48	95% Approximate Gamma UCL (use when n>=50))	375.4	95% Adjusted Gamma UCL (use when n<50)																											
49			378.6																											

ProUCL Output
Main Plant ISS Area Soil (0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L
50												
51	Lognormal GOF Test											
52		Shapiro Wilk Test Statistic		0.938								
53		5% Shapiro Wilk Critical Value		0.941								Data Not Lognormal at 5% Significance Level
54		Lilliefors Test Statistic		0.134								
55		5% Lilliefors Critical Value		0.137								Data appear Lognormal at 5% Significance Level
56	Data appear Approximate Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59		Minimum of Logged Data		3.686								Mean of logged Data 5.333
60		Maximum of Logged Data		6.852								SD of logged Data 0.904
61												
62	Assuming Lognormal Distribution											
63		95% H-UCL		429.8								90% Chebyshev (MVUE) UCL 455.9
64		95% Chebyshev (MVUE) UCL		523.2								97.5% Chebyshev (MVUE) UCL 616.6
65		99% Chebyshev (MVUE) UCL		800.1								
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71		95% CLT UCL		361.2								95% Jackknife UCL 362.7
72		95% Standard Bootstrap UCL		359.8								95% Bootstrap-t UCL 369.2
73		95% Hall's Bootstrap UCL		364.5								95% Percentile Bootstrap UCL 361.3
74		95% BCA Bootstrap UCL		366.8								
75		90% Chebyshev(Mean, Sd) UCL		413								95% Chebyshev(Mean, Sd) UCL 464.9
76		97.5% Chebyshev(Mean, Sd) UCL		537								99% Chebyshev(Mean, Sd) UCL 678.6
77												
78	Suggested UCL to Use											
79		95% H-UCL		429.8								
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												
86	ProUCL computes and outputs H-statistic based UCLs for historical reasons only.											
87	H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.											
88	It is therefore recommended to avoid the use of H-statistic based 95% UCLs.											
89	Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.											
90												

ProUCL Output
Central Landfill ISS Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L											
1	UCL Statistics for Data Sets with Non-Detects																						
2																							
3	User Selected Options																						
4	Date/Time of Computation	ProUCL 5.17/30/2018 9:42:29 AM																					
5	From File	20180727_fluoride_ISS_for_proucl_a.xls																					
6	Full Precision	OFF																					
7	Confidence Coefficient	95%																					
8	Number of Bootstrap Operations	2000																					
9																							
10																							
11	Fluoride																						
12																							
13	General Statistics																						
14	Total Number of Observations	32										Number of Distinct Observations 32											
15												Number of Missing Observations 0											
16	Minimum	10.4										Mean 232											
17	Maximum	976										Median 82.4											
18	SD	259.9										Std. Error of Mean 45.95											
19	Coefficient of Variation	1.12										Skewness 1.378											
20																							
21	Normal GOF Test																						
22	Shapiro Wilk Test Statistic	0.788										Shapiro Wilk GOF Test											
23	5% Shapiro Wilk Critical Value	0.93										Data Not Normal at 5% Significance Level											
24	Lilliefors Test Statistic	0.243										Lilliefors GOF Test											
25	5% Lilliefors Critical Value	0.154										Data Not Normal at 5% Significance Level											
26	Data Not Normal at 5% Significance Level																						
27																							
28	Assuming Normal Distribution																						
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																		
30	95% Student's-t UCL	309.9										95% Adjusted-CLT UCL (Chen-1995) 319.6											
31												95% Modified-t UCL (Johnson-1978) 311.8											
32																							
33	Gamma GOF Test																						
34	A-D Test Statistic	0.936										Anderson-Darling Gamma GOF Test											
35	5% A-D Critical Value	0.782										Data Not Gamma Distributed at 5% Significance Level											
36	K-S Test Statistic	0.189										Kolmogorov-Smirnov Gamma GOF Test											
37	5% K-S Critical Value	0.161										Data Not Gamma Distributed at 5% Significance Level											
38	Data Not Gamma Distributed at 5% Significance Level																						
39																							
40	Gamma Statistics																						
41	k hat (MLE)	0.867										k star (bias corrected MLE) 0.806											
42	Theta hat (MLE)	267.7										Theta star (bias corrected MLE) 287.8											
43	nu hat (MLE)	55.47										nu star (bias corrected) 51.6											
44	MLE Mean (bias corrected)	232										MLE Sd (bias corrected) 258.4											
45												Approximate Chi Square Value (0.05) 36.1											
46	Adjusted Level of Significance	0.0416										Adjusted Chi Square Value 35.41											
47																							
48	Assuming Gamma Distribution																						
49	95% Approximate Gamma UCL (use when n>=50))	331.6										95% Adjusted Gamma UCL (use when n<50) 338.1											
50																							

ProUCL Output
Central Landfill ISS Area Soil (0-0.5 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L
51	Lognormal GOF Test											
52			Shapiro Wilk Test Statistic		0.947							
53			5% Shapiro Wilk Critical Value		0.93							
54			Lilliefors Test Statistic		0.129							
55			5% Lilliefors Critical Value		0.154							
56	Data appear Lognormal at 5% Significance Level											
57												
58	Lognormal Statistics											
59			Minimum of Logged Data		2.342							Mean of logged Data 4.769
60			Maximum of Logged Data		6.883							SD of logged Data 1.252
61												
62	Assuming Lognormal Distribution											
63			95% H-UCL		478.9							90% Chebyshev (MVUE) UCL 447.3
64			95% Chebyshev (MVUE) UCL		537.8							97.5% Chebyshev (MVUE) UCL 663.3
65			99% Chebyshev (MVUE) UCL		909.9							
66												
67	Nonparametric Distribution Free UCL Statistics											
68	Data appear to follow a Discernible Distribution at 5% Significance Level											
69												
70	Nonparametric Distribution Free UCLs											
71			95% CLT UCL		307.6							95% Jackknife UCL 309.9
72			95% Standard Bootstrap UCL		306							95% Bootstrap-t UCL 321.4
73			95% Hall's Bootstrap UCL		317.5							95% Percentile Bootstrap UCL 309
74			95% BCA Bootstrap UCL		317.6							
75			90% Chebyshev(Mean, Sd) UCL		369.9							95% Chebyshev(Mean, Sd) UCL 432.3
76			97.5% Chebyshev(Mean, Sd) UCL		519							99% Chebyshev(Mean, Sd) UCL 689.2
77												
78	Suggested UCL to Use											
79			95% H-UCL		478.9							
80												
81	Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.											
82	Recommendations are based upon data size, data distribution, and skewness.											
83	These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).											
84	However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.											
85												
86	ProUCL computes and outputs H-statistic based UCLs for historical reasons only.											
87	H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.											
88	It is therefore recommended to avoid the use of H-statistic based 95% UCLs.											
89	Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.											
90												

ProUCL Output
Central Landfill ISS Area Soil (0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L																		
1	UCL Statistics for Data Sets with Non-Detects																													
2																														
3	User Selected Options																													
4	Date/Time of Computation	ProUCL 5.17/30/2018 8:44:15 AM																												
5	From File	20180727_fluoride_ISS_for_proucl_b.xls																												
6	Full Precision	OFF																												
7	Confidence Coefficient	95%																												
8	Number of Bootstrap Operations	2000																												
9																														
10																														
11	Fluoride																													
12																														
13	General Statistics																													
14	Total Number of Observations	64	Number of Distinct Observations																											
15			Number of Missing Observations																											
16	Minimum	10.4	Mean																											
17	Maximum	976	Median																											
18	SD	257.3	Std. Error of Mean																											
19	Coefficient of Variation	1.119	Skewness																											
20																														
21	Normal GOF Test																													
22	Shapiro Wilk Test Statistic	0.772	Shapiro Wilk GOF Test																											
23	5% Shapiro Wilk P Value	3.341E-13	Data Not Normal at 5% Significance Level																											
24	Lilliefors Test Statistic	0.242	Lilliefors GOF Test																											
25	5% Lilliefors Critical Value	0.111	Data Not Normal at 5% Significance Level																											
26	Data Not Normal at 5% Significance Level																													
27																														
28	Assuming Normal Distribution																													
29	95% Normal UCL				95% UCLs (Adjusted for Skewness)																									
30	95% Student's-t UCL				95% Adjusted-CLT UCL (Chen-1995) 288.9																									
31					95% Modified-t UCL (Johnson-1978) 284.6																									
32																														
33	Gamma GOF Test																													
34	A-D Test Statistic	2.002	Anderson-Darling Gamma GOF Test																											
35	5% A-D Critical Value	0.785	Data Not Gamma Distributed at 5% Significance Level																											
36	K-S Test Statistic	0.195	Kolmogorov-Smirnov Gamma GOF Test																											
37	5% K-S Critical Value	0.115	Data Not Gamma Distributed at 5% Significance Level																											
38	Data Not Gamma Distributed at 5% Significance Level																													
39																														
40	Gamma Statistics																													
41	k hat (MLE)	0.899	k star (bias corrected MLE) 0.867																											
42	Theta hat (MLE)	255.8	Theta star (bias corrected MLE) 265.1																											
43	nu hat (MLE)	115.1	nu star (bias corrected) 111																											
44	MLE Mean (bias corrected)	230	MLE Sd (bias corrected) 246.9																											
45					Approximate Chi Square Value (0.05) 87.71																									
46	Adjusted Level of Significance	0.0463	Adjusted Chi Square Value 87.23																											
47																														
48	Assuming Gamma Distribution																													
49	95% Approximate Gamma UCL (use when n>=50))	291.1	95% Adjusted Gamma UCL (use when n<50) 292.7																											
50																														

ProUCL Output
Central Landfill ISS Area Soil (0-2 ft-bgs)
Columbia Falls Aluminum Facility
Columbia Falls, Montana

	A	B	C	D	E	F	G	H	I	J	K	L					
51						Lognormal GOF Test											
52					Shapiro Wilk Test Statistic	0.937		Shapiro Wilk Lognormal GOF Test									
53					5% Shapiro Wilk P Value	0.00387		Data Not Lognormal at 5% Significance Level									
54					Lilliefors Test Statistic	0.139		Lilliefors Lognormal GOF Test									
55					5% Lilliefors Critical Value	0.111		Data Not Lognormal at 5% Significance Level									
56					Data Not Lognormal at 5% Significance Level												
57																	
58					Lognormal Statistics												
59					Minimum of Logged Data	2.342		Mean of logged Data									
60					Maximum of Logged Data	6.883		SD of logged Data									
61																	
62					Assuming Lognormal Distribution												
63					95% H-UCL	342.9		90% Chebyshev (MVUE) UCL									
64					95% Chebyshev (MVUE) UCL	435.4		97.5% Chebyshev (MVUE) UCL									
65					99% Chebyshev (MVUE) UCL	685.8											
66																	
67					Nonparametric Distribution Free UCL Statistics												
68					Data do not follow a Discernible Distribution (0.05)												
69																	
70					Nonparametric Distribution Free UCLs												
71					95% CLT UCL	282.9		95% Jackknife UCL									
72					95% Standard Bootstrap UCL	282.3		95% Bootstrap-t UCL									
73					95% Hall's Bootstrap UCL	292.2		95% Percentile Bootstrap UCL									
74					95% BCA Bootstrap UCL	288.6											
75					90% Chebyshev (Mean, Sd) UCL	326.5		95% Chebyshev (Mean, Sd) UCL									
76					97.5% Chebyshev (Mean, Sd) UCL	430.8		99% Chebyshev (Mean, Sd) UCL									
77					Suggested UCL to Use												
78					95% Chebyshev (Mean, Sd) UCL	370.2											
79																	
80																	
81					Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.												
82					Recommendations are based upon data size, data distribution, and skewness.												
83					These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).												
84					However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.												
85																	



Attachment C Venison COPC Uptake Model

Preliminary - Under EPA and MDEQ Review

Table C-1
Example Calculation for the Ingested Dose of Fluoride in Venison Tissue by the Hunter

Human Health Exposure Area	Soil Concentration	Biotransfer Factor for Venison (Bv) (Bv = 0.2 x Bb)		Forage Tissue Concentration, Dry Matter (Cp) (Cp = Cs x BAF _{plant})		Venison Concentration (Cv) (Cv = (Cp x FIR _{browse} x Bv) + (Cs x FIR _{browse} x f _{SI} x Bv))			AUF (unitless) (AUF = Area _{Site} x Area _{Foraging Range})			AUF-Adjusted Venison Concentration (mg/kg ww) (Cv _{Adjusted} = Cv x AUF)
	Cs (mg/kg dw) ^a	Bb (D/kg tissue ww)	Bv (D/kg tissue ww)	BAF _{plant} (kg soil dw/kg plant tissue dw)	Cp (mg/kg plant tissue dw)	FIR _{browse} (kg DM/d)	f _{SI}	Cv (mg/kg ww)	Area of Site (acres) ^b	Area of Deer Foraging Range (acres) ^b	AUF (unitless)	
Main Plant Area	43.89	0.15	0.03	0.06	2.6334	0.87	0.02	0.09	150.2	997.7	0.151	0.014
North Percolation Pond Area	221	0.15	0.03	0.06	13.26	0.87	0.02	0.5	3.2	997.7	0.003	0.001
Central Landfills Area	84.92	0.15	0.03	0.06	5.0952	0.87	0.02	0.2	127.8	997.7	0.128	0.023
Industrial Landfill Area	4.17	0.15	0.03	0.06	0.2502	0.87	0.02	0.01	18.3	997.7	0.018	0.000
Eastern Undeveloped Area	0	0.15	0.03	0.06	0	0.87	0.02	0.0	99.9	997.7	0.100	0.000
North-Central Undeveloped Area	12.2	0.15	0.03	0.06	0.732	0.87	0.02	0.0	182.9	997.7	0.183	0.005
Western Undeveloped Area	10.68	0.15	0.03	0.06	0.6408	0.87	0.02	0.0	357.3	997.7	0.358	0.008
South Percolation Pond Area	17.95	0.15	0.03	0.06	1.077	0.87	0.02	0	49.1	997.7	0.049	0.002
Backwater Seep Sampling Area	32.7	0.15	0.03	0.06	1.962	0.87	0.02	0	8.8	997.7	0.009	0.001
											EPC _{venison}	0.053

Notes:

C_s = concentration in soil (mg/kg dry weight)

B_b = biotransfer factor for beef (d/kg tissue wet weight)

AUF = aereal ratio of exposure area to receptor foraging range (unitless)

B_v = biotransfer factor for venison; Bb adjusted to Bv multiplying Bb by 0.2 based on the ratio of % fatvenison/% fatbeef (2.9 / 14.4 = 0.2)

BAF_{plant} = soil-to-plant forage bioaccumulation factor (kg soil dry weight / kg plant forage tissue dry weight)

C_p = Concentration in plant forage tissue (mg/kg plant dry weight)

FIR_{browse} = browse ingestion rate (kg dry plant tissue/day)

C_v = concentration in venison tissue (mg/kg venison wet weight)

f_{SI} = Fraction of FIR_{browse} associated with incidental soil ingestion

I_r_v = ingestion rate of venison (kg venison wet weight/day)

EF = exposure frequency (days/year)

ED = exposure duration (years)

BW = body weight (kg)

AT = averaging time (noncancer) (days)

mg/kg = milligrams per kilogram

mg DM/d = milligrams dry matter per day

kg/d = kilograms per day

d/yr = days per year

yr = year

kg = kilograms

d = days

mg/kg-d = milligrams per kilogram per day

mg/kg ww = milligrams per kilogram wet weight

^a Soil concentrations based on exposure point concentrations (EPCs) calculated for surface soil (0 - 0.5 ft bgs) for each exposure area. Refer to text for discussion on development of soil EPCs.

If soil data not available for an exposure area, the soil concentration set to 0 for the purposes of calculation.

^b Values presented are the vegetated portions of the exposure area and Site. See table below for non-vegetated and vegetated areas for each human health exposure area.

Human Health Exposure Area	AOC	Area		
		Non-Vegetated (Acres)	Vegetated (Acres)	Total (Acres)
Main Plant Area	1	140.0	150.2	290.1
North Percolation Pond Area	2	8.0	3.2	11.3
Central Landfills Area	3	0.0	127.8	127.8
Industrial Landfill Area	4	0.0	18.3	18.3
Eastern Undeveloped Area	5	0.0	99.9	99.9
North-Central Undeveloped Area	6	0.0	182.9	182.9
Western Undeveloped Area	7	0.0	357.3	357.3
South Percolation Pond Area	8	0.0	49.1	49.1
Backwater Seep Sampling Area	9A	0.0	8.8	8.8
Total		148.0	997.7	1145.7